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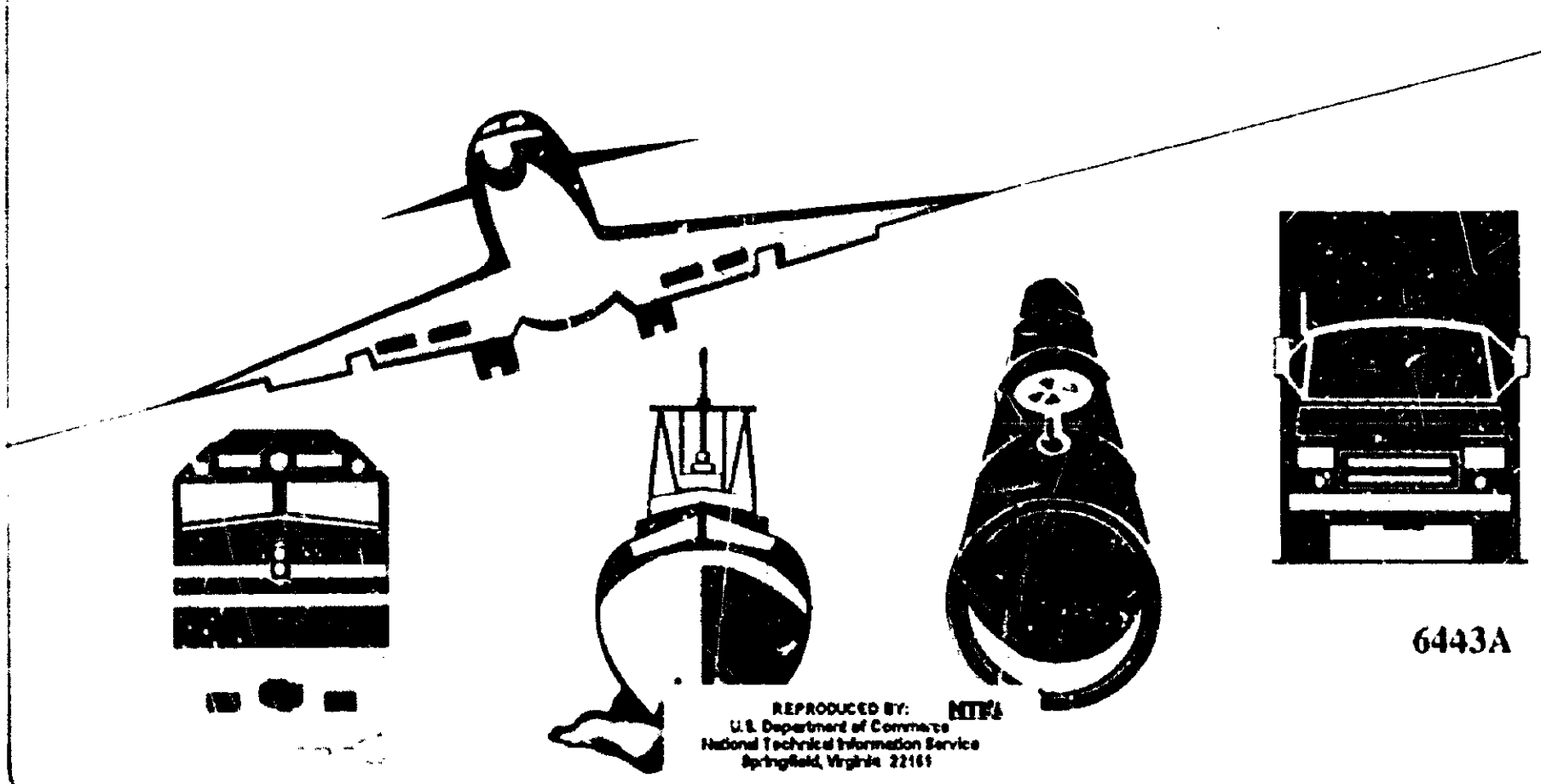
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NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

MARINE ACCIDENT REPORT

FIRE ON BOARD
U.S. FISH PROCESSING VESSEL ALL ALASKAN
NEAR UNIMAK ISLAND, ALASKA
BERING SEA
JULY 24, 1994



6443A

REPRODUCED BY:
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Abstract: On July 24, 1994, the U.S. fish processing vessel ALL ALASKAN caught fire and burned out of control for several days. The vessel at the time of the fire was bound for Dutch Harbor, Unalaska Island, Alaska, after a processing voyage in the Bering Sea. A deckhand was killed, and the estimated damage was between $25.3 and $31 million.

The major safety issues discussed in this report are fire protection and construction standards, heat tape installation, firefighting training, fire watch procedures, and postaccident toxicological testing procedures as well as employee medication use.

As a result of its investigation, the National Transportation Safety Board issued safety recommendations to the U.S. Coast Guard, All Alaskan Seafoods, Inc., Commercial Fishing Industry Vessel Safety Advisory Committee, and National Fire Protection Association.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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U.S. FISH PROCESSING VESSEL ALL ALASKAN
NEAR UNIMAK ISLAND, ALASKA
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JULY 24, 1994

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Adopted: July 11, 1995
Notation 6443A

NATIONAL
TRANSPORTATION
SAFETY BOARD

WASHINGTON, D.C. 20594

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EXECUTIVE SUMMARY

About 0930 on July 24, 1994, while bound for Dutch Harbor, Alaska, in the Aleutian Chain, the U.S. fish processing vessel ALL ALASKAN caught fire near the western end of Unimak Island, Alaska. The fire burned out of control for several days before burning itself out. One person died, and the vessel and cargo damage was estimated between $25.3 and $31 million.

The National Transportation Safety Board determined that the probable cause of the fire aboard the ALL ALASKAN was the failure to isolate heat tape from combustible rigid polyurethane insulation and the lack of heat tape standards for fish processing vessels. Contributing to the severity of the fire was the lack of adequate firefighting (detection and suppression systems) standards. Contributing to the loss of life was the lack of formal firefighting training of the fire team.

The major safety issues discussed in this report are:

1. Fire protection and construction standards for fish processing vessels.
2. Heat tape installation on the ALL ALASKAN.
3. Adequacy of firefighting training for crewmen aboard uninspected fish processing vessels.
4. Fire watch procedures on the ALL ALASKAN.
5. U.S. Coast Guard and company postaccident toxicological testing procedures as well as the company awareness of medication use that may affect an employee's ability to perform duties.

As a result of this accident, the National Transportation Safety Board makes recommendations to the U.S. Coast Guard; All Alaskan Seafoods, Inc.; Commercial Fishing Industry Vessel Safety Advisory Committee; and National Fire Protection Association.

INVESTIGATION

Accident

About 0930 Alaskan daylight time on July 24, 1994, the U.S. fish processing vessel[1] ALL ALASKAN caught fire and burned while en route to Dutch Harbor, Unalaska Island, Alaska, after a processing voyage in the Bering Sea. The vessel at the time of the fire was about 13 miles west northwest of Cape Sarichef on the western end of Unimak Island, Alaska. (See figure 1.)

Preaccident Events -- The ALL ALASKAN departed Clarks Point, Bristol Bay, on the northwest side of the Alaskan peninsula during the afternoon of July 22, 1994. Approximately 150 fish processing personnel (processors) disembarked before departure, reducing the vessel complement to 133 people (the master, the operating crew, and the remaining processors). Before getting underway that afternoon, the master assigned three processors to fire watch duty on a 4-hour watch rotation, known as the 12-4, 4-8, and 8-12 watches. He routinely ordered a fire watch whenever the vessel was underway and not processing. The master testified, "foam insulation is a concern to me" and he set the fire watch for that reason. The master instructed the fire watch to "make rounds every half an hour through the housing [crew quarters], the factory [processing] deck, the 'tween decks [freezer or second deck], freezers [cargo holds], and the main deck, [see figures 2 and 3] and report smoke or anything in there that did not look right."

At 0100 on July 24 during a fire watch inspection of the vessel, which included the three refrigerated cargo holds in which the temperature was about -26 °F, the 12-4 fire watch noticed an unidentifiable odor in hold No.3. He reported this odor to the reefer (refrigeration) technician on the 1800-0600 watch,[2] who testified that between 0130 and 0200, he went into the holds to check on the odor and that the odor was stronger in hold No.3. He stated, "I could smell it again by the stairwell [on the aft bulkhead port side leading down from the freezer deck] coming down in there, but then it dissipated the longer I stayed down [there]."

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[1]Defined under 46 United States Code (USC) 2101 (11b) and 46 Code of Federal Regulations (CFR) 28.50 as "a vessel that commercially prepares fish or fish products other than by gutting, decapitating, gilling, skinning, shucking, icing, freezing, or brine chilling." The processing activities can include mincing, filleting, preparation of fish meal, boiling (crab), or a combination of these to prepare the seafood for direct marketing as well as packaging the product.

[2]Each of the two refrigeration technicians and the two engineers had one of the 12-hour watch shifts, which were 1800-0600 and 0600-1800.

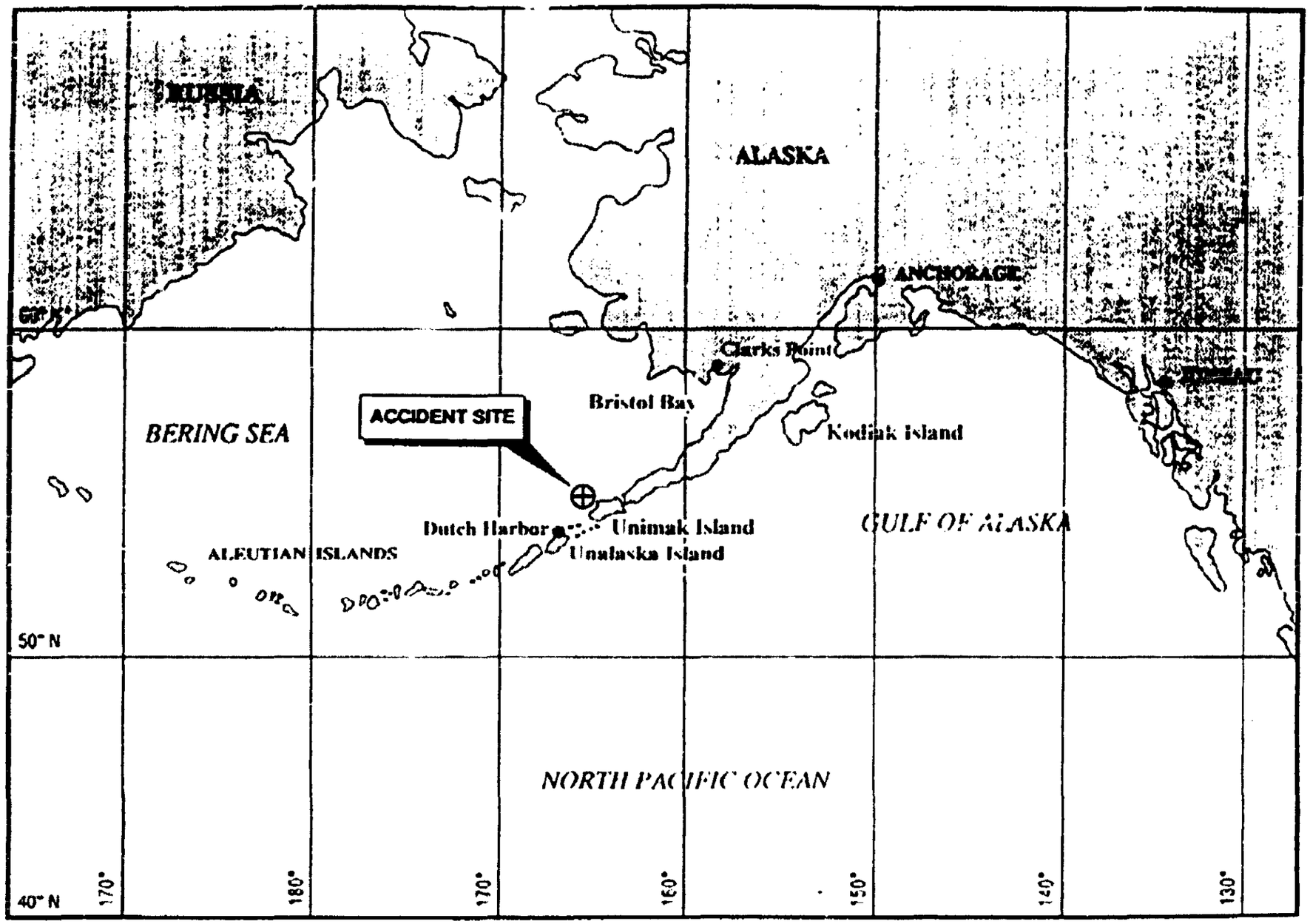


Figure 1– Accident site.

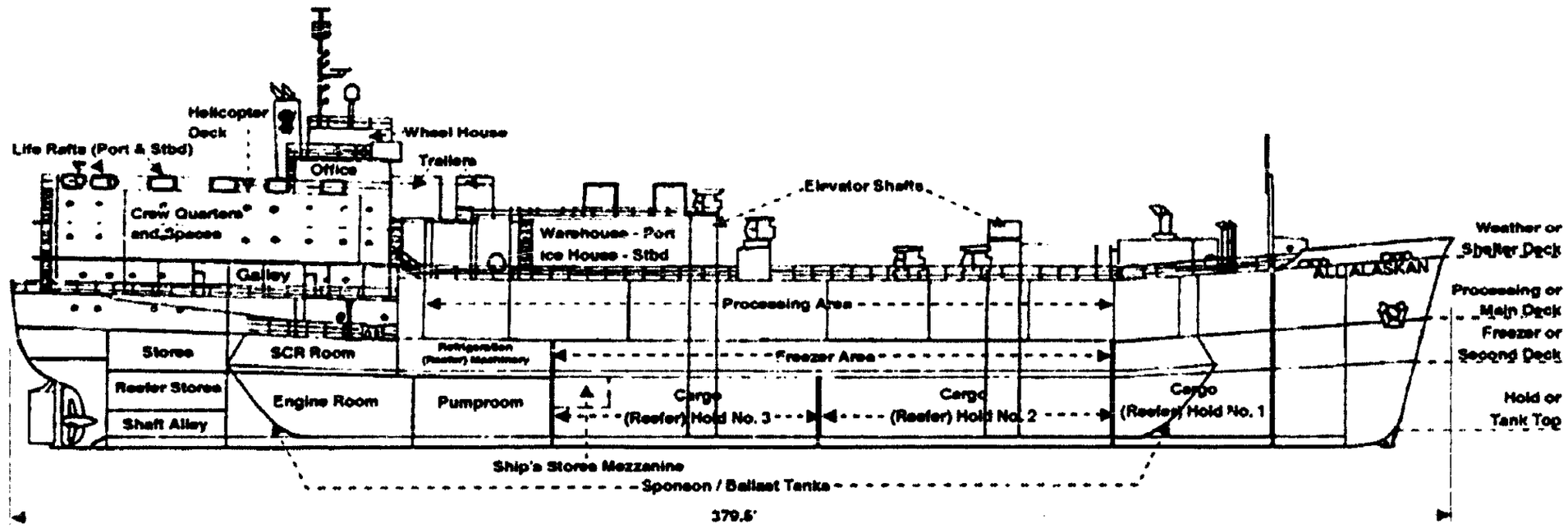


Figure 2 -- Side view of ALL ALASKAN and plan layout of its weather or shelter deck.

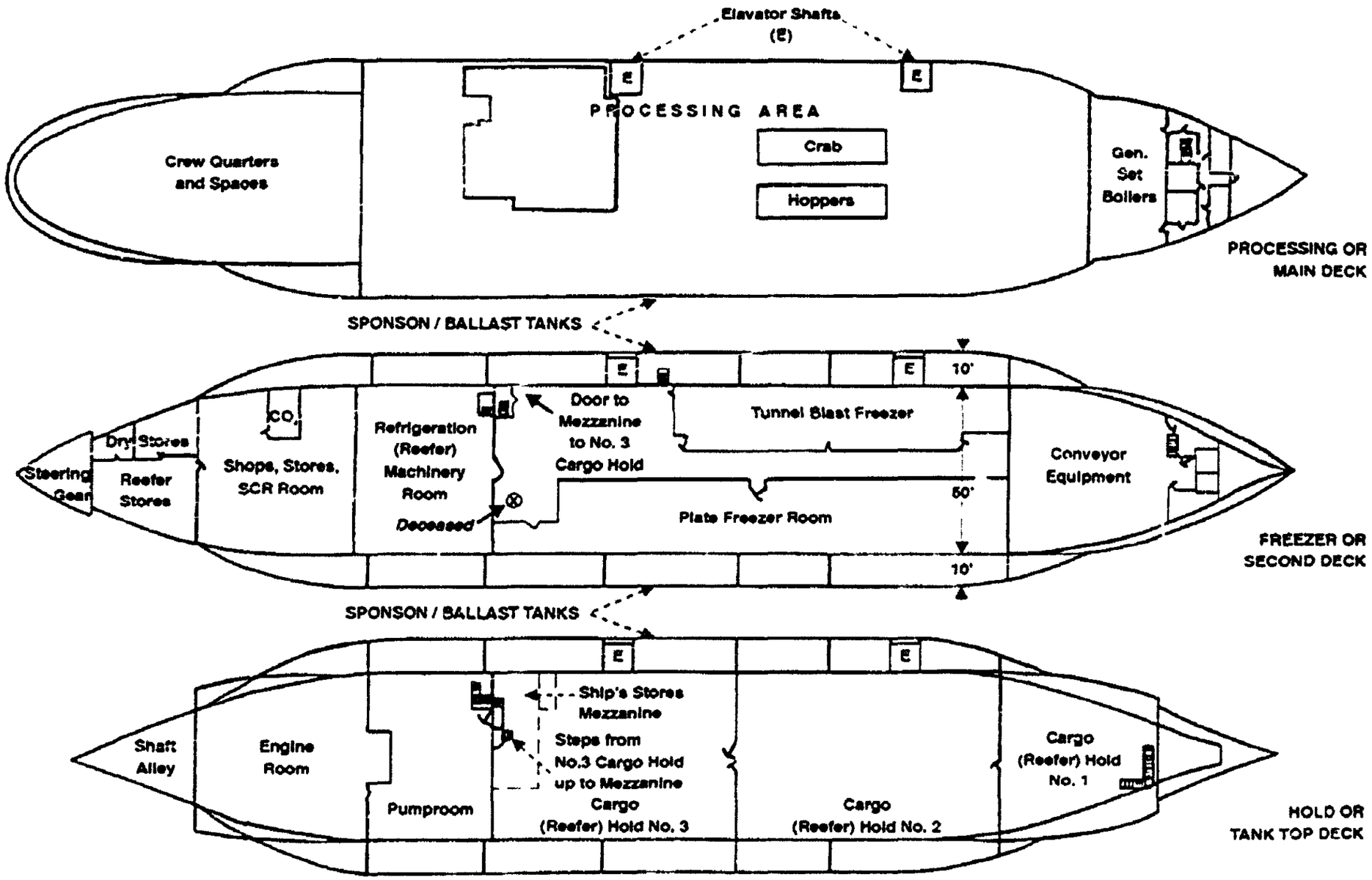


Figure 3 -- Plan layout of ALL ALASKAN processing or main, freezer or second, and hold or tank top decks.

The refrigeration technician told the night shift processor foreman[3] about the odor. They went into hold No.3, looked around, and did not see anything unusual. The foreman suggested that the technician contact the assistant engineer on watch, who then toured the cargo holds about 0200. The watertight doors[4] between the cargo holds were open. The assistant engineer said he "realized the smell was in freezer three [hold No.3]." He and the technician looked at the junction boxes, aft elevator, lights, and evaporator fans, but they could not locate or identify the odor. The assistant engineer then instructed the fire watch and the refrigeration technician to "keep an eye on it" during their subsequent inspections. He did not notify any superior in the "chain of command." The refrigeration technician stated that he checked the spaces hourly until about 0500 without noticing any increase in the odor or any sign of smoke. The assistant engineer, the refrigeration technician, and the fire watch were unable to identify the odor or to discover its source. They testified that they had smelled burning heat tape before, but this odor did not smell like burning heat tape. The bridge watch was not notified of the odor. When the master was later asked what he would have done had he been informed of the strange odor, he testified that he would have "sent a team down there with hoses, a fire team down there, and stopped the vessel and investigated it."

The swing shift (0000-1200) processor foreman testified that the refrigeration technician and the night shift foreman had informed him of the odor in hold No.3. He went through the holds between 0200 and 0300 to check the odor for himself. He entered through hold No.3, walked through hold No.2, and exited through hold No.1. The odor that he smelled in hold No.3, as described by him, "wasn't exactly like a fan belt burning, but something to that effect. I wasn't able to tell exactly what it was, but it was a different odor than I'd ever smelled in that area before." He stated that he walked through the three holds three additional times and that during the last time about 0610, he believed the odor was stronger in hold No.3 and now noticeable in hold No.2. He neither discovered the source nor reported his findings to anyone.

The 4-8 fire watch testified that when he came on duty, the 12-4 fire watch told him about the odor in hold No.3 and to give particular attention to that area when making the ship rounds. The 4-8 fire watch stated that he made two rounds every hour, on the hour and on the 1/2 hour, and each round lasted about 20 minutes. He and the swing shift processor foreman further checked the holds for the source of the odor about 0600, and their inspection failed to reveal that source. The 4-8 fire watch stated that he continued his rounds until he was relieved at 0800.

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[3]The three processor foremen's 12-hour watch shifts were 1800-0600 (night), 0600-1800 (day), and 0000-1200 (swing).

[4]Metal doors in a watertight bulkhead that when closed, prevent water under pressure from passing through.

The 8-12 fire watch testified that he was told about the odor in hold No.3 when he relieved the previous fire watch. He stated that he made his regular rounds, on the hour and on the 1/2 hour, starting at 0800 from the galley, proceeding to the crew quarters, the weather deck, the trailers, down the deck to the warehouse, toward the forward stairwell, then the freezer deck, through the holds, and back through crew quarters, and returning to the galley. He recalled that he made his last inspection of the holds between 0910 and 0915 and did not notice any smoke or fire.

When the 0600-1800 watch refrigeration technician came on duty, he changed the elements in an oil separator, completing the job by 0800. He then toured the holds and noticed the odor in hold No.3. He stated that after passing through hold No.1, he met the 8-12 fire watch and "made him aware again that there was something down there and told him to keep an eye on it." The technician returned to the refrigeration machinery room to set up an oil change for one of the machines in the refrigeration room. He testified that about 0925, he went onto the freezer deck to check that oil was not leaking into the freezer deck and then returned to the refrigeration machinery room. He recalled that at the time, no smoke was visible around the closed insulated door to hold No.3, which was in the port aft corner of the freezer deck about 20 feet from the refrigeration machinery room watertight door near the centerline on the aft bulkhead. He said, however, "walking back [about 0930] to make another round through the freezer [holds], . . . that's when I seen the heavy brown smoke coming out of the freezer door."

When the refrigeration technician discovered smoke coming from the closed insulated door to hold No.3, he immediately went to the assistant engineer who was on watch in the engineroom and reported it. Both men then returned together to look at the door from which the smoke continued to exit before notifying the master and the chief engineer. The refrigeration technician telephoned from the galley to notify the master who was on watch in the wheelhouse. The technician then awakened the chief engineer and informed him of the smoke and the possible fire in the hold.

Fire -- The master immediately sounded the general alarm, which signaled the crew to proceed to the fire and emergency stations. The processing crew went to their abandon ship stations while the operating crew reported to their fire stations, as instructed in the ship station bill.

The sound of the general alarm awakened the chief mate, who reported to the wheelhouse where he was informed of the fire in hold No.3. The master ordered him below to assess the situation and to report back to the wheelhouse with recommendations. The chief mate used a hand-held radio for contact with the master, who remained in the wheelhouse.

An able seaman (AB) and a deckhand on watch in the wheelhouse had overheard the master's telephone conversation with the refrigeration technician about the fire in hold No.3 and, according to the AB, on their own initiative left the wheelhouse for the fire locker. (The other deckhand on watch at that time remained in the wheelhouse at the steering station.) Once at the fire locker, which was port side aft on the weather deck, each put on a firefighter's coat and a self-contained breathing apparatus (SCBA). The AB carried a fire extinguisher. They went down through the housing area and the refrigeration machinery room to assess the fire. The AB said he told the deckhand "to keep his left hand on the bulkhead at all times and not miss any turns." When they reached the insulated door to hold No.3, the AB stated,

> [I] felt the door and didn't feel any change of temperature, so I opened up the door and [the deckhand] and I stood back. I put my hand up to the [opened] door [way] and felt a gust of heat coming through, so I turned and said it's really hot down there and that we can't go down in there.

Within 2 or 3 seconds of opening the door, according to the AB, a flame burst through the door, and flames prevented him from closing the door. The AB turned again and motioned to the deckhand that they had to escape. The AB said that the deckhand moved ahead (to starboard) faster than he did and "when we got back to the watertight [door], we had come through [from the] refrigeration [machinery room], he turned left and started running towards the bow and that's the last time I saw him--he disappeared in the smoke." The AB waited and called out the deckhand's name for 15 to 30 seconds before he left the space. (See figure 4.)

Meanwhile, the chief mate and a processor foreman went forward beyond the trailers and encountered considerable smoke near the forward end of the warehouse. They descended to the weather deck level on the starboard side and proceeded around the stern to the fire locker on the port side of the galley where the fire team was mustering and had collected emergency equipment. Attempting to control the fire, the fire team stretched the hoses and sprayed water into a hatch, which descended to the processing deck, but the heat and smoke from that deck and the freezer deck prevented them from entering the spaces below.

The AB stated that the dense smoke in the refrigeration machinery room disoriented him, but he recognized a beam that enabled him to proceed towards the stern and up a ladder to the processing deck. When he met the refrigeration technician, they continued together to the weather deck. The AB telephoned the master in the wheelhouse and informed him that flames were coming onto the middeck through the hatch. The AB then returned to the fire locker where the fire team members had assembled and asked whether anyone had seen the deckhand. No one had. The AB and the chief engineer, wearing SCBA gear, attempted to locate the missing deckhand on the processing deck, but the progression of the fire prevented them. The chief mate decided, after talking to the AB and observing the smoke and fire conditions, that any effort to search for the missing deckhand would be futile.

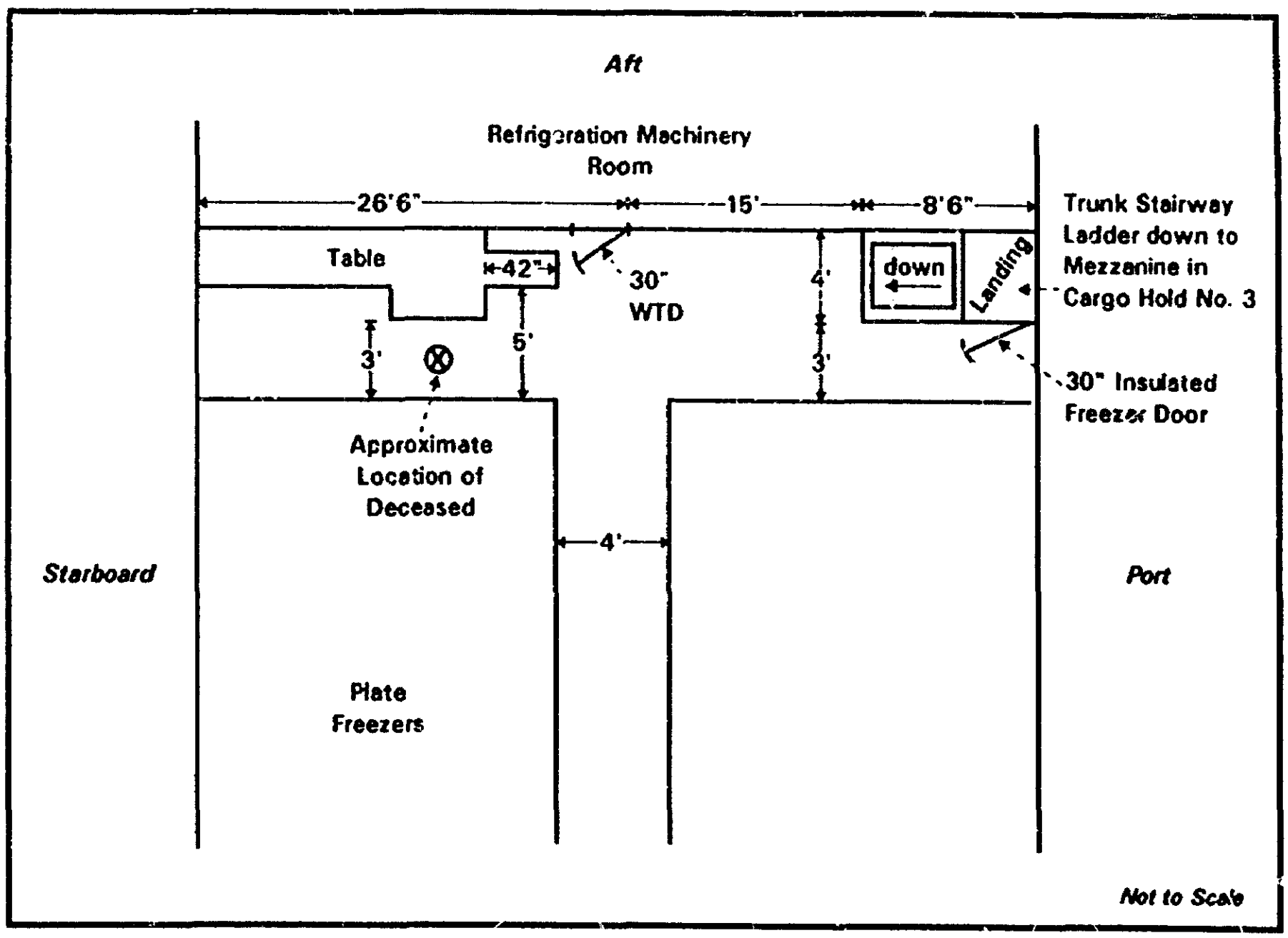


Figure 4 -- Illustration of second or freezer deck aft section.

Survival and Rescue – Most crewmembers were sleeping when the sound of the general alarm alerted them of the fire. Personnel on duty in the galley, in accordance with vessel procedures, banged on stateroom doors with spoons and yelled fire. The ALL ALASKAN was equipped with rope ladders, and three ladders were hung over the sides of the vessel near the stern for everyone to disembark the vessel. The processors and crewmembers were accounted for as they reported with their immersion suits to the assigned liferafts on the helicopter deck. Because large explosions with heavy smoke occurred forward of the wheelhouse, the master ordered the crewmembers to the main deck aft until the liferafts were in the water. (See figure 5.) Exploding gasoline drums and some cylinders with compressed acetylene, oxygen, and ammonia, which were stowed on the weather deck, propelled metal fragments in all directions.

The master broadcast a distress message at 0938 that the ALL ALASKAN was afire. The vessel was about 13 miles west northwest of Cape Sarichef on the western end of Unimak Island. The U.S. Coast Guard communications station on Kodiak Island, Alaska, received the message at 0939 and advised the Northern Pacific SAR (search and rescue) Coordinator (NPSC) in Juneau, Alaska, of the ALL ALASKAN distress message. Crewmembers on the 378-foot high-endurance Coast Guard cutter JARVIS, which was about 70 miles from the ALL ALASKAN on northern Pacific patrol duties, also heard the distress message. The JARVIS was ordered to the scene by the NPSC at 0942. The ALL ALASKAN master advised the JARVIS at 1003 that the fire was out of control and that his crew was abandoning ship into liferafts. The intense smoke forced the master to leave the wheelhouse at 1021. The JARVIS launched a helicopter at 1023, which proceeded to the scene.

While transiting the area with one barge in tow, the commercial tug PT. MILNE responded at 1037 to the ALL ALASKAN distress transmission. The ALL ALASKAN master used a VHF-FM portable radio when the PT. MILNE arrived on scene to ask its captain to maneuver the tug to remove people from the processing vessel. Crewmembers and processors, wearing immersion suits, descended the rope ladders from the main deck onto the PT. MILNE or into liferafts, which had been deployed alongside the ALL ALASKAN. A processor fell from a ladder into the water and was quickly pulled on board a liferaft by crewmembers.

The helicopter from the JARVIS arrived on scene by 1043, observed the evacuation with the people wearing immersion suits on the stern, and remained ready to assist in the rescue operations. The helicopter pilot said, "[the ALL ALASKAN] was ablaze from the main superstructure forward, yellow flames, black billowing smoke. It was pretty overwhelming when we got there." The pilot, using VHF channel 16, asked the master whether anyone was injured. His answer was no, but he added a deckhand was missing on the burning ship. The master told him that all the others aboard had been mustered around the main deck railing at the stern of the vessel. The pilot and copilot were surveying the helicopter deck on the ALL ALASKAN as a possible landing site when an explosion at the forward end of the vessel propelled debris about. The pilot withdrew the helicopter from the area because debris could

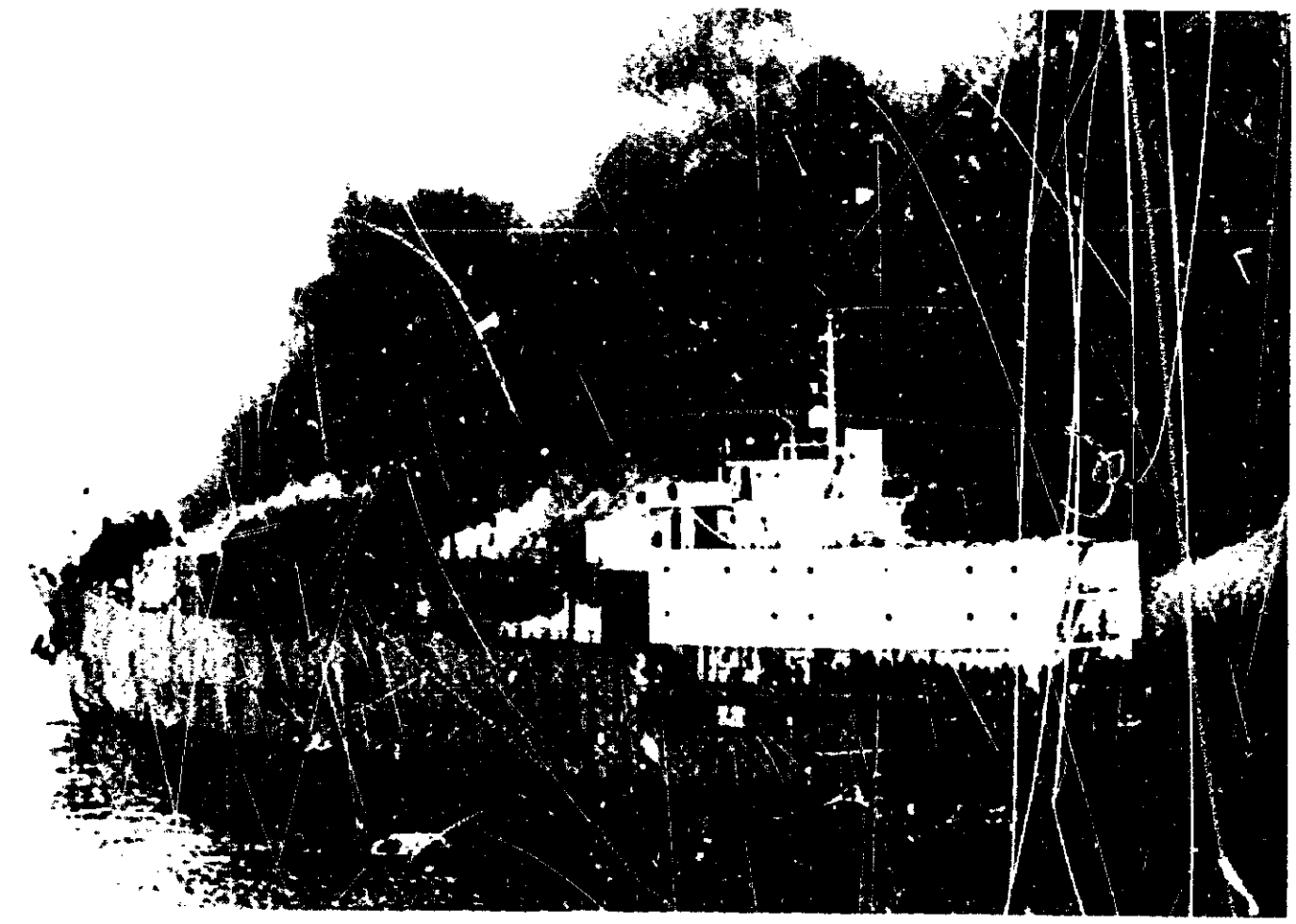


Figure 5 -- Photograph of ALL ALASKAN on fire.
(Courtesy of U.S. Coast Guard)

have hit its rotors. Upon returning to the ALL ALASKAN, the pilot saw the vessel personnel boarding the PT. MILNE and noted "people were very calm. It was organized. Nobody was panicking."

The master of the fish processing vessel INDEPENDENCE also heard the ALL ALASKAN distress message on VHF channel 16 and responded that his vessel, which was about 17 miles away, could arrive on scene in about 2 hours and had a registered nurse on board. When the INDEPENDENCE arrived, its skiff conveyed the nurse with portable oxygen bottles to the PT. MILNE to attend an ALL ALASKAN crewmember who had suffered smoke inhalation. The ALL ALASKAN crewmembers and processors had been transferred by 1215 onto either the PT. MILNE or the liferafts. The master and the chief mate left the ALL ALASKAN last. The master plus the 131 crewmembers and processors were reported on board the PT. MILNE by 1223. (The deckhand who participated in the initial fire assessment activity was still missing.) The ALL ALASKAN crewmembers, except the master, and processors had begun transferring by 1243 from the PT. MILNE to the INDEPENDENCE. All were on board the INDEPENDENCE, accounted for, and en route to Dutch Harbor at 1319.

The master of the ALL ALASKAN was transferred to the JARVIS, which had arrived on scene at 1230, and he remained aboard to provide technical information about his vessel. The ALL ALASKAN was carrying 120,000 gallons of fuel (diesel oil) and was to be towed to prevent its grounding on Unimak Island. (The ALL ALASKAN had drifted and was about 8 miles from the island.) The fishing vessel SHELIKOF, which had also received the ALL ALASKAN distress transmission, arrived on scene about 1415 to assist. The ALL ALASKAN master and two JARVIS crewmembers boarded the ALL ALASKAN about 1654 to rig an emergency tow to the SHELIKOF. The ALL ALASKAN was in tow by 1711, and the JARVIS provided escort. After the tow commenced, the master and the two crewmembers returned to the JARVIS. At 2000 on July 24, the JARVIS made an inspection of the waters around the ALL ALASKAN and found no visible pollution from the vessel. An earlier pollution sheen had been present from gasoline stowed in barrels that had exploded on deck during the fire.

At 0904 on July 25, the tug IMPALA, which was contracted by All Alaskan Seafoods, Inc. (AAS), the owner and operator of the ALL ALASKAN, relieved the SHELIKOF and took the burning vessel in tow. At 0800 on July 26, only light traces of white smoke were present, indicating that the fire was almost out. The ALL ALASKAN anchored with no visible smoke at 0900 on July 29 in Captain's Bay, Unalaska Island; however, black smoke was seen at 2030 coming from an engineroom ventilator, which indicated the fire was still present. The fire was declared out at 1430 on July 30, 1994.

An Alaskan state trooper and the ALL ALASKAN master and crewmembers subsequently boarded the vessel on July 30 and located the body of the missing deckhand on the freezer deck forward and starboard of the refrigeration machinery room watertight door

above hold No.3. The deckhand was found wearing gloves, a firefighter's coat, and a SCBA face mask and air tank. This equipment was severely burned.

Injuries

	Vessel Complement
Fatal	1
Minor	2
None	130
Total	133

Vessel Damage

The ALL ALASKAN fish processing plant, which included the cargo hold machinery, the freezer deck, the processing deck, and the weather (shelter) deck, was either damaged or destroyed by the fire. The heat damage to the hull structure warped steel decks and distorted deck beams, while the fire completely destroyed the navigating bridge and its equipment.

The AAS reported that the ALL ALASKAN vessel damage was estimated between $24.3 and $30 million, the insured and market value of the vessel, respectively. The AAS also recorded the fish cargo damage to be about $1 million.

Personnel Information

The 133 people on board the ALL ALASKAN before the fire included 9 crewmembers in the deck department, 4 engineers, 108 processors, and 12 office and staff personnel. The master, the chief mate, the chief engineer, and the assistant engineer were the only people on board required to have a license and were properly licensed (see appendix B) by the Coast Guard for this vessel.

Master -- The master testified that he began sailing in 1976 as an unlicensed seaman and sailed on deep sea vessels until 1981. When he moved to Alaska, he worked as a crab fisherman from 1981 until 1986. Personnel records indicate that he was hired by AAS in December 1986 as a deckhand. He obtained a mate's license in 1989 and then worked as a mate aboard an AAS fish processing vessel. He received his master's license in 1991 and was appointed master of the ALL ALASKAN, a position he held until the vessel burned. (He stood the 0600-1800 watch on the ALL ALASKAN.) He testified that he had not been involved in any previous marine accidents or incidents; company and Coast Guard records show no involvement in previous marine accidents or incidents.

The master stated he had received advanced firefighting training at North Bend, Washington, and Bayonne, New Jersey. He added that he had also received formal first aid and CPR (cardiopulmonary resuscitation) training in 1992 and lifeboatman training in 1979.

The master testified that he had been under the care of a physician since September 1992 and that as part of his treatment, he took 100 mg of the antidepressant medication Zoloft (Sertraline) every morning. The physician noted that the master took no other medications that might interact with Zoloft and considered that the nonsedating medication Zoloft "would be unlikely to interfere whatsoever with a ship's master's performance." The master stated that he had never experienced any adverse effects from the medication.

Before the accident, according to the master, he had informed the AAS in writing that he was taking Zoloft. The president of AAS said that he was not aware before the accident that the master had been taking this medication. Furthermore, the company did not have a policy on medication use and potential effects on performance or guidelines for crewmembers who took medications. A review of the master's AAS personnel medical file revealed no record of his notifying the company that he was taking Zoloft.

Chief Mate -- The chief mate had worked mostly in the commercial fishing industry since 1971. He served aboard offshore supply vessels between 1981 and 1985 to increase the tonnage limitations on his license, issued by the Coast Guard in 1982. He resumed working on fishing vessels in 1985. He had served aboard other fish processing vessels from 1985 until he joined the ALL ALASKAN as chief mate on June 5, 1994. (He stood the 1800-0600 watch on the ALL ALASKAN.) He had attended a navigation school as well as two firefighting schools.

Chief Engineer -- The chief engineer worked between 1976 and 1982 in an unlicensed capacity in the offshore oil industry. He obtained a chief engineer's license in 1982, working as chief engineer and port engineer on west coast offshore supply vessels before he joined the crew of the ALL ALASKAN in November 1991. (He stood the 0600 to 1800 watch on the ALL ALASKAN; however, the assistant engineer had taken the morning watch on the day of the accident because the chief engineer had worked late the night before.)

Assistant Engineer -- The assistant engineer began working in the commercial fishing industry in 1984 and joined the crew of the ALL ALASKAN in May 1989. (He stood the 1800 to 0600 watch aboard the ALL ALASKAN.) The Coast Guard issued him a limited chief engineer's license in April 1994.

Able Seaman -- The AB had worked aboard the ALL ALASKAN for 4 years, which was his only seagoing experience. The Coast Guard issued him seaman papers for an able seaman-fishing industry in October 1992. (He stood the 0600-1800 deck watch on the ALL ALASKAN.) The AB had routinely participated in shipboard fire drills; however, he neither had nor was required to have formal firefighting training.

Deckhand -- The deckhand who perished in the fire was hired by the AAS as a fish processor and worked periodically in 1993 and 1994, which was his only seagoing experience. (He stood the 0600 to 1800 deck watch aboard the ALL ALASKAN.) His last physical examination was on June 4, 1994, in which he was found to be healthy. The deckhand neither had nor was required to have formal firefighting training.

Vessel Information

The ALL ALASKAN was built originally as a 341.3-foot general cargo vessel (Maritime Administration design C1-M-AV1, commonly known as a knot ship). It was named the HORSESHOE SPLICE when launched in December 1945 at Savannah, Georgia. The vessel was converted in 1975 into an oil drill ship and renamed the OCEAN TEMPEST. During the conversion, it was lengthened 38.2 feet and widened 20 feet (10-foot-wide sponson/ballast tanks were added on both sides of the parallel midbody of the hull). It was inspected and last issued a 2-year Coast Guard Certificate of Inspection (COI) that expired on December 13, 1987. The vessel was converted in 1988 into a fish processing vessel and renamed the ALL ALASKAN; however, to operate as a fish processing vessel required no Coast Guard inspection. (See the Coast Guard regulations in the Fish Processing Vessels section of this report.) The ALL ALASKAN was issued certificates of compliance with the International Convention for the Prevention of Pollution from Ships by Oil and the International Convention of Load Lines. The American Bureau of Shipping (ABS) classed the vessel and its machinery *(Maltese Cross) A1 Fishing Vessel and *(Maltese Cross) AMS,[5] respectively.

The principal characteristics of the ALL ALASKAN were:

Length Overall	379.5 feet	(115.67 meters)
Breath	70.0 feet	(21.33 meters)
Depth	28.7 feet	(8.75 meters)
Gross Tonnage	4,875	
Net Tonnage	3,667	
Deadweight	6,401 long tons	
›rsepower	5,850	

The navigation and communication equipment in the wheelhouse included a direction finder, three depth sounders, a gyro-compass, a magnetic compass, two radars, four radio telephones, four electronic position fixing devices, and satellite communication apparatus.

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[5]This classification indicates that the vessel and its machinery had been built in accordance with the ABS rules. The Maltese Cross indicates the vessel was built under special survey and supervision; the Maltese Cross AMS indicates the highest classification of machinery.

The ALL ALASKAN had diesel electric propulsion. The three GM 16-cylinder diesel engines, installed in 1975, could produce 5,850 horsepower. These engines drove three 1,500 KW generators that were connected to four electric motors and geared to a single propeller shaft. The on-board refrigeration plant used ammonia for its cargo refrigeration system that had a cooling capacity rated at 1,622,000 KCal (536.2 tons) per hour at -40°F.

The deckhouse aft had 73 staterooms to quarter 269 people, and the two house trailers stowed on deck forward of the deckhouse could accommodate 32 people.

Firefighting and Lifesaving Equipment -- According to the AAS records, a fire pump and an auxiliary fire pump were connected to a manifold that distributed water to fire stations throughout the ALL ALASKAN. On board the vessel were fire suits, portable fire extinguishers, six 30-minute SCBAs (the regulations for this vessel required two), and a compressor for refilling empty SCBA air cylinders. Remote shut-offs for the engineroom fuel pumps and tanks and ventilation were on the main deck. The AB testified that the fire locker contained about five fire suits, four SCBAs, axes, flashlights, gloves, boots, fire extinguishers, helmets, two lifelines, and spare compressed-air bottles.

A fixed carbon dioxide firefighting system, which could be activated from the main deck, was piped into the engineroom and emergency generator room. The system for the engineroom had 17 100-pound compressed carbon dioxide cylinders with an aural alarm to warn personnel when carbon dioxide is released.

The ALL ALASKAN was equipped with safety flares, a battery-powered radio, and an EPIRB (emergency position indicating radio beacon) that could be used if the vessel was in distress. Also on board the vessel were 8 ring life buoys with lights, 280 immersion suits,[6] and 14 inflatable liferafts that could accommodate a maximum of 330 people. The ALL ALASKAN could accommodate 301 people, and the AAS would provide additional immersion suits when more than 280 people were carried aboard the vessel.

On-Board Combustibles -- The master of the ALL ALASKAN drew a sketch for the Coast Guard after the accident showing 200 pallets of cardboard fiber, used as boxes for frozen fish or crab, on top of the shelter deck storage containers. An additional 60 pallets of cardboard fiber and 4 large inflatable mooring fenders were stowed in the crab hoppers. Wooden pallets and food on pallets were stored along the aft bulkhead of hold No.3 on the mezzanine.

Two 55-gallon drums of gasoline were kept near the hold No.2 cargo hatch on the starboard side of the weather deck. In addition, pressurized ammonia bottles, used for replenishing the refrigeration system, and oxygen and acetylene bottles were stowed on the port side of the hold No.2 hatch.

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[6]Title 46 CFR 28.110 requires that a commercial fishing industry vessel be equipped with at least one immersion suit, exposure suit, or wearable flotation device of the proper size for each individual on board.

All Alaskan Seafoods, Inc. -- A group of Alaskan fishermen formed the AAS in 1975 and then in 1976 purchased a processing vessel, which processed catches primarily from stockholder-owned vessels. The AAS main office in Seattle, Washington, had a support and management staff of 18 people. At the time of this accident, the company owned three vessels: the ALL ALASKAN, the NORTHERN ALASKAN (a processing barge), and the ALASKAN GRAND ISLE (not in operation).

The AAS president, when describing the operations, indicated: 1) the master made all operational decisions about the ALL ALASKAN, 2) the on-board vessel superintendent managed the processing operation, and 3) the president administered the company. The president stated that he had visited the ALL ALASKAN routinely, while underway and at anchor, either to review the fish processing operation or to meet with customers and their representatives.

The shipboard employee evaluation was informal, and no written record was prepared. The superintendent of the processing operations and the foreman for each watch evaluated the processors every 2 to 4 months at the expiration of each contract. The master testified, "If you keep your job there, you know you're doing your job."

Waterway Information

The fire aboard the ALL ALASKAN occurred while the vessel was underway in the Bering Sea at latitude 54° 39'N and longitude 165° 48'W. This position was about 13 miles west northwest of Cape Sarichef on Unimak Island, approximately 63 miles northeast from Dutch Harbor, nearly 360 miles from Kodiak Island to the east northeast, and about 580 miles from Anchorage, Alaska, to the northeast.

Unimak Island is the first island in the Aleutian Islands chain, which stretches westward from the Alaskan peninsula in a 700-mile arc. The Unimak Pass on the southwest side of the island is the easternmost waterway through which tugs, barges, larger vessels, and fishing vessels from southeast Alaska pass into the Bering Sea.

Meteorological Information

At the time of the accident, the seas had 2-foot waves and a 4-foot ground swell. The air and water temperatures were 49 °F and 47 °F, respectively. The winds were from the west at 15 knots; the sky was overcast, and visibility was good. Although the JARVIS watchstanders were 15 to 20 miles from the burning ALL ALASKAN, they reported seeing smoke.

Postaccident Vessel Examination

The intense heat of the fire warped and buckled steel decks and bulkheads throughout the fish processing area, including two freezer deck bulkheads near the hold No.3 hatch and four bulkheads at the forward end of the processing deck. Watertight doors throughout the processing area showed heat and fire damage, and the fire destroyed all rubber gaskets. The main deck stairwell enclosures and the two elevator shafts from the freezer deck to the processing deck were also damaged from the intense heat. The entire processing deck was gutted, which included its two elevators to the refrigerated holds. The forward machinery space on the processing deck housed two steamboilers and an auxiliary generator that were heat and smoke damaged.

The two house trailers on the weather deck forward of the deckhouse were completely destroyed. The incinerator room, ice house, and warehouse burned also. The weather deck plating was distorted from the intense heat. On the side shell plating on the port side of the elevator shafts, the paint burned off. Five storage containers, stowed on the forward end of the weather deck, were incinerated.

The crew quarters, including the galley and messroom, had smoke damage but no fire damage. A closed fire screen door from the wheelhouse to the officers' quarters on the deck below prevented the fire from spreading into the crew quarters. The fire that spread upward from the weather deck gutted the wheelhouse and its navigation equipment.

Machinery -- The deck machinery, which included four hydraulic deck cranes, elevator and vertical conveyor machinery, and the fans and motors in various exhaust stacks as well as the associated piping and electrical wiring, was destroyed. Two mooring capstans and the two anchor windlasses on the bow were heavily heat damaged.

The refrigeration compressors in the refrigeration machinery room were lightly heat damaged; however, the piping and electrical wiring were mostly destroyed. The watertight door from this space to the freezer deck was open and its gasket burned off. The center and starboard main engines received damage from overheating and possible crankcase explosions. Three main propulsion generators and four main propulsion motors sustained heat damage. The electrical control panel wiring for the engineroom machinery, which provided power to the processing machinery, the refrigeration compressors, the lighting, and the heat tape throughout the vessel, was also damaged. The heat tape on the vertical refrigeration evaporator drain pipe in the after port side of hold No.3 was so extensively burned that only two wires, which provided the current to the heat tape, remained.

Insulation -- The hull, the bulkhead, and the overhead (ceiling) of the holds as well as the two decks above (freezer and processing decks) had been sprayed with 8 to 10 inches of rigid polyurethane (RPU) foam for thermal insulation. In sections of the three freezer holds, the RPU insulation was covered with 3/4-inch, 8-foot high plywood sheathing, fastened to

two-by-fours attached horizontally to the hull frame, as protection from the cargo-loading and -unloading activities.

Flame Spread and Fire Damage -- The RPU foam insulation was consumed as fuel for the fire extensively in the after port corner of hold No.3. The damage to insulation in the remainder of hold No.3 and in the other two holds was mainly near the overhead from heat and smoke. This damage lessened toward the forward bulkhead of hold No.3. The lowest point of the fire appears to have occurred in hold No.3 on the port side between the aft elevator and the aft bulkhead. The fire spread was primarily through open doors and the two elevator shafts. The aft bulkhead separated hold No.3 from the pump room. (See figure 6.) In addition, the RPU foam insulation and the plywood sheathing in hold No.3 were completely burned away from the aft elevator opening to the aft bulkhead from overhead to deck. The plywood covering the horizontal drain pipe on the port after side was also burned.

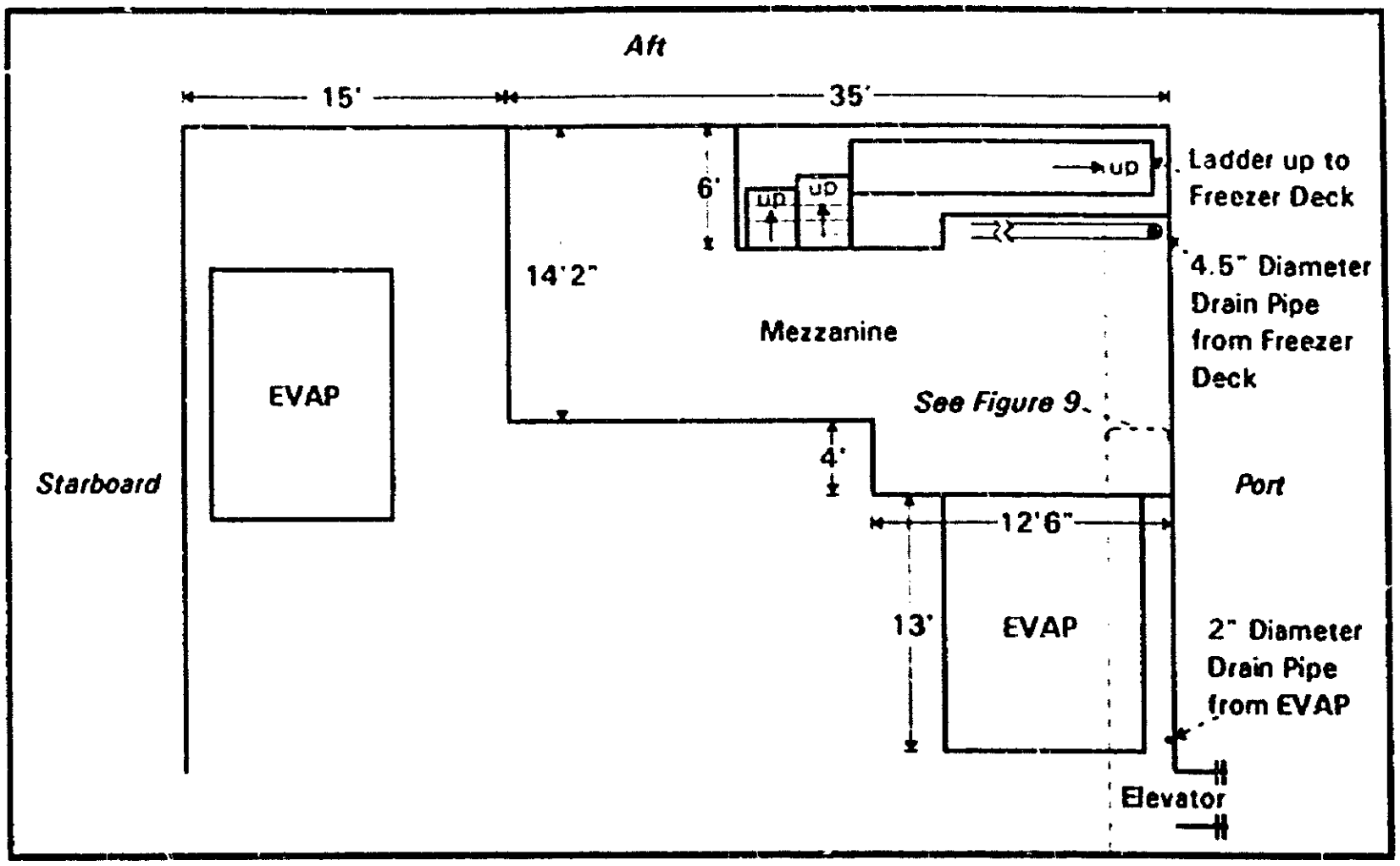
Although in hold No.2 some RPU foam insulation fell from the overhead, this hold and hold No.1 had little evidence of fire and received mostly smoke and heat damage. The RPU foam insulation that was used extensively throughout the processing and freezer decks was burned completely.

The aft and forward elevator shafts on the port side of the holds No.3 and No.2, respectively, which were also lined with RPU foam insulation, were burned completely. The two elevators had provided access to these holds for loading and unloading cargo. The outside of the vessel hull on the port side showed extensive heat damage. Its paint was vertically scorched off down to the freezer deck level (just above the water line), which corresponded to the forward elevator shaft. A vertical section, corresponding to the after elevator shaft, also exhibited heat damage on the exterior of the ship hull; however, this heat damage advanced only to the processing deck level. The entry to the aft cargo elevator shaft in hold No.3 was enclosed with a roll-up rubberized material that remained intact with minor heat and smoke damage. A similarly constructed roll-up door covering the entry to the forward elevator shaft in hold No.2 was intact with no fire damage. Both doors were found closed after the fire.

Access to the aft elevator shaft on the freezer deck was through a large watertight door that was discovered open about 2 feet. The 14 dogs[7] on this door were examined, and soot deposits were observed on the latches, dogs, and debris around the door seal. The door to the aft elevator shaft on the processing deck was found closed after the fire.

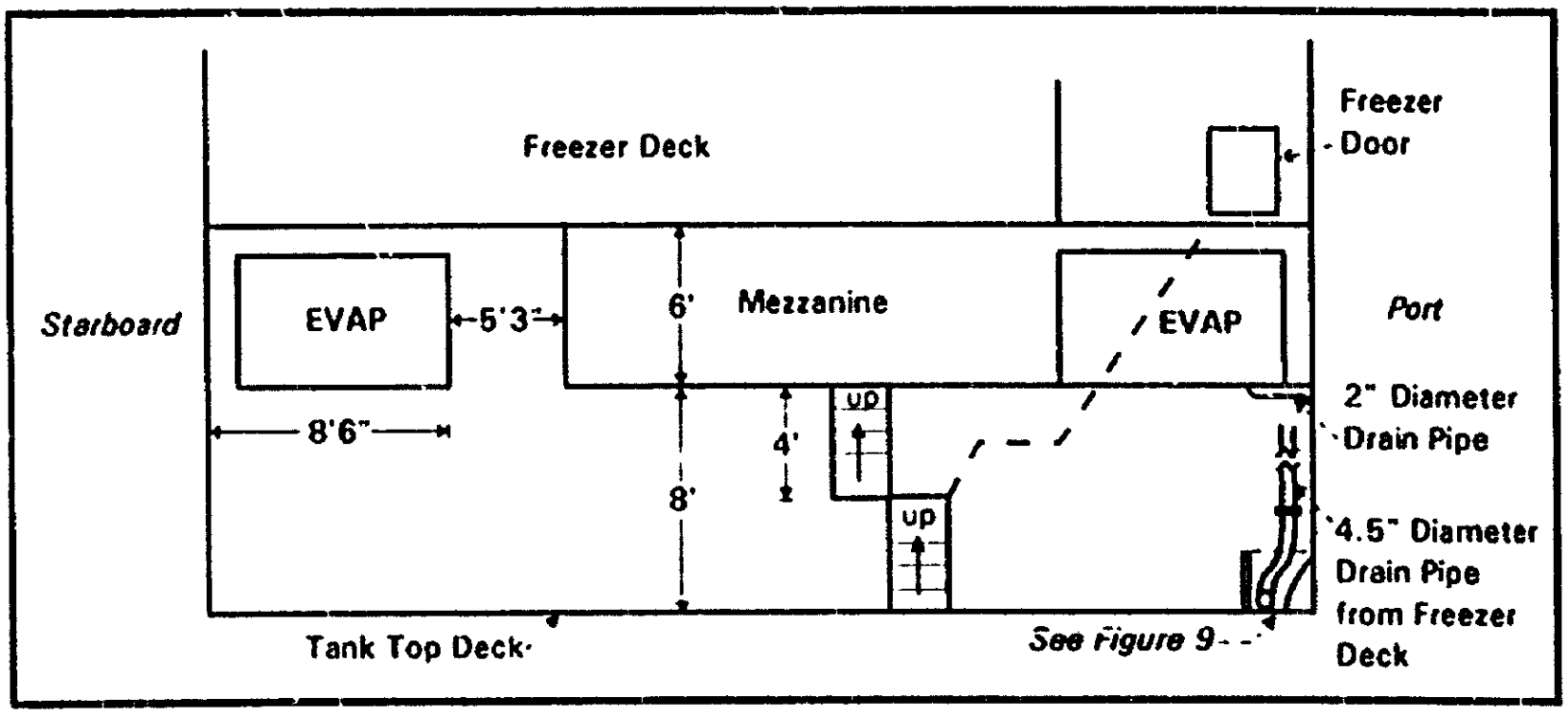
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[7]Handles operated from either side of hinged watertight doors to force the door frame against its gasket.



Plan View

Not to Scale



Side View

Figure 6 -- Plan and side views of cargo hold No.3 aft section.

According to the master of the ALL ALASKAN, the forward elevator shaft on the freezer deck had no access. This opening apparently had been closed off and covered with RPU insulation. The investigation on the freezer deck indicated that the insulation covering was consumed as fuel completely during the fire, which left the forward elevator shaft opening uncovered. Access to the forward elevator shaft from the processing deck was through a double watertight door that was found open about 1 foot. An elevated walkway prevented this door from being opened any farther.

Medical, Pathological, and Toxicological Information

Six crewmembers were examined for injuries on July 25 and 26 at the Iliuliuk Family and Health Services, Inc., on Unalaska Island. Two crewmembers had sustained a contusion and smoke inhalation.

The autopsy performed on the deceased deckhand determined the cause of death was asphyxia from smoke inhalation. The toxicological analysis did not indicate the presence of alcohol or other drugs in the deckhand.

Toxicology testing began at 1240 on July 25 and was completed at 1450 on July 26 at the Iliuliuk Family and Health Clinic on Unalaska Island. Twenty crewmembers and two processors provided urine specimens; neither breathalyzer tests were administered nor blood specimens collected for alcohol testing. Of the 22 urine specimens analyzed, one from a processor tested positive for a metabolite of marijuana. At the time of the accident, this processor had been off duty and asleep. The investigation disclosed that he was neither required to have nor had a preemployment drug test when he was hired on May 16, 1994.

The AAS personnel stated that either the master or the emergency medical technician onboard the vessel was responsible for postaccident drug and alcohol testing of crewmembers. The chief mate testified that he, acting on behalf of the AAS in Dutch Harbor, consulted with the on-scene Coast Guard investigating officer (IO) about the testing. He identified 22 individuals, including himself, to provide specimens. Although unable to recall specifically who was tested, he stated that those tested individuals would have included "licensed officers, anybody with an AB card, fire watches." Because the health clinic was closed on the day of the accident, he arranged for postaccident testing of those individuals for the following morning.

The AAS said the on-scene Coast Guard IO from the Marine Safety Office in Anchorage advised that Coast Guard personnel aboard the JARVIS would administer the postaccident drug testing to the master. The IO informed National Transportation Safety Board investigators that he notified an attorney, who had arrived in Dutch Harbor to represent the AAS, that only the crew should undergo postaccident drug testing and that the Coast Guard would attempt to drug test the master either onboard the JARVIS or in Dutch Harbor. The

Coast Guard did not conduct any postaccident alcohol or drug testing of the master, and according to the commanding officer of the JARVIS, the subject was never discussed. The commanding officer and the deck officers of the JARVIS indicated that the master exhibited no evidence of having ingested alcohol or other drugs before the accident. AAS personnel in Seattle stated that they were unaware the master did not have postaccident toxicological testing. They indicated that he allegedly underwent postaccident testing "somewhere on the East Coast" several weeks after the accident; however, the AAS could not provide any drug testing documentation.

The master stated that he was not requested to provide specimens for postaccident drug and alcohol testing during his 3 days aboard the JARVIS and was unable to explain why the Coast Guard did not require him to be tested. He further stated that after the initial discussion with Coast Guard personnel about postaccident testing, it was not pursued or commented on again. He also said that he never discussed the subject of postaccident chemical testing with AAS officials because company personnel were busy with other accident-related matters, such as securing the ship and attending to the crew.

The Safety Board requested of both the master and the AAS, orally and in writing, on several occasions subsequent to the accident that the former have postaccident chemical testing. The master, however, never underwent this drug and alcohol testing. (The master also stated that several weeks after the accident, he traveled to Russia to fish for the AAS.)

Fire Drills

Fish processing vessels are required by the Coast Guard, as specified in 46 CFR 28.270, to hold drills monthly, which include abandon ship and fighting fire. The master testified, and other crewmembers and processors agreed, that drills were held more frequently while the ALL ALASKAN was underway. The last drill was held on July 23, the day before the fire. The AB and the deckhand who had attempted to assess the fire had both participated in fire drills on board the ALL ALASKAN. The drills consisted of donning SCBAs and fire suits, laying hoses, simulating mock fires, and discussing duties listed on the station bill.

The master testified that during fire drills,

> [W]e'd muster at the fire station at the fire locker after the crew had been instructed on how to abandon ship, don SCBAs, the fire gear, stretch hoses out with applicators. On numerous occasions, we would put a man down into an area, a confined area, and then bring him out on a stretcher. A lot of just putting the--getting them familiar with wearing the self-contained breathing apparatus [and with] the hoses.

The assistant engineer stated that during the on-board drills, members of the fire team would report to the fire locker and wait for the chief mate who routinely supervised the fire team's organizing, obtaining equipment, and deciding the method of approach to extinguish a mock fire. After reporting to the locker, the fire team was told where the fire would take place; the members performed their assigned duties, which were indicated on the station bill; then, fire team members went to the scene of the mock fire.

The AB who had initially responded to the fire testified, "Every time we have a fire drill, we assemble at the fire locker and go over the equipment and put on suits and SCBAs and everything." He added that the members discuss their duties according to the station bill and "we go over the--you know given the situation we were in, if it's a smoky area...keep your hand on something at all times. Don't wander out into the open or anything like that." The AB also said that he had not been trained to use lifelines during fire drills.

The AB stated that he did not know of any manuals, instructions, or lesson plans aboard the ALL ALASKAN used for firefighting training. He testified that he had not received training in fire containment. He further stated, "When we do a mock fire and such, it's just--it's verbal training." When asked whether his training included classifying a fire and determining the type of extinguisher to use, he responded, "I do know that you don't use water on an electrical fire....I pretty much know what type of extinguisher...not to use on an oil fire."

Fire team members were selected based on their position on the ALL ALASKAN and not on firefighting background. Because processors were hired as factory laborers, they did not necessarily have a marine background and were not assigned to the fire team. Should a processor become a deckhand, however, he would be assigned to the fire team.

Firefighting Training

The AAS president stated that as the company president, crew training in safety is his responsibility as well as that of the vessel master and a safety consultant under contract to the AAS and that it was conducted according to Coast Guard regulations (46 CFR 28.270). The safety consultant had developed the *All Alaskan Seafoods Safety Operations Manual* for the

ALL ALASKAN in 1991 and revised it in 1993. This manual consists of five sections: (1) Corporate Safety Program and Policies; (2) Employee Safety Training and Orientation; (3) Emergency Procedures; (4) Accident Reporting, Recordkeeping, and Investigation; and (5) Appendices.[8] The November 1991 *Shipboard Firefighting Operational and Procedure Manual for Crew Members of All Alaskan Seafoods* is appendix O.

The safety operations manual contains the crew guidelines for firefighting operations, including the procedures to assess and to control a fire as well as the required resources to fight a fire. According to the manual, the chief mate uses the fire assessment to develop a fire attack plan and to coordinate the firefighting efforts. The manual warns that "when ventilating large areas or when first opening up, caution should be used to prevent a back draft.[9] Note: Have a charged line [fire hose with water pressure] standing by."

The manual also contains the SCBA-use guidelines that advise:

> when fully charged, the unit will give the user, approximately 30 minutes of air. This [length of time] can vary greatly depending on how big the person is and how out of breath they are when first putting the unit on...there is a bell that sounds notifying the user that they have at least 5 minutes of air remaining and

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[8]A-1, Employee Orientation Checklist/Sign off Form - Seattle; A-2, Employee Orientation Checklist/Sign off Form - Onboard; A, Employee Safety Orientation Checklist; B, Lockout/Tagout Program; D, Monthly Inspection Checklist; E, Hazard Communication Program; F, Medical Evacuation Report Checklist; G, Accident Witness Statement; H, Respiratory Protection Program; I, Physical Hazards Handouts; J, Bloodborne Pathogens Control Program; K, Ammonia/Fire Respiratory Protection; L, SCBA/Canister Mask Inspection Forms; M, Ammonia Emergency Response Plan; N, HAZWOPER 8 Hour Training Outline; O, Shipboard Firefighting Procedures.

[9]A back draft or a flash over condition occurs when a fire burns in an enclosed space and consumes the oxygen in that space. The fire becomes oxygen limited and continues to burn at a slower rate. The incomplete combustion process puts combustible gases into the atmosphere. To create a flash over, a smoldering fire needs only oxygen, which the opening of a door can provide.

should leave the danger area....Note: A life line (100' x 1/2") should be attached to the air pack when going into any difficult areas....[10]

A lifeline, used during rescue, firefighting, or other emergency operations, consists of a wire rope with hooks on each end to attach to a harness. Before a person enters a space wearing a harness with attached lifeline, the prearranged signals must be understood by both the wearer and the person monitoring the line outside the space. The lifelines on the ALL ALASKAN were stowed in the vessel fire locker.

Coast Guard-approved facilities can provide formal basic and advanced marine firefighting training for vessel personnel. The training includes fire protection and suppression and hands-on training using mock-ups, simulations for fire suppression, and rescue. Firefighting strategies and tactics, using a team approach, is also available at these facilities. This formal training is only required for Coast Guard-licensed officers.

Ignition Sources

The Safety Board investigated several possible ignition sources that included the heat tape, the evaporator fan motors, the heating pads on the drain collector pans under the evaporators, the electric circuits in hold No.3, and lighted tobacco materials. The master prohibited smoking, except on the galley/mess deck and outside stern areas, and testified that personnel were told, "Any smoking in the housing will result in immediate termination." The

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[10]U.S. Maritime Administration publication *Marine Fire Prevention, Firefighting and Fire Safety*, researched, developed, and produced by Robert J. Brady Co. for the National Maritime Research Center (contract No. MA-2-4362), states:

> Whenever possible, crewmen wearing breathing apparatus should work in pairs. In all cases, a lifeline must be tied to the fire fighter using the demand-type breathing apparatus [self contained breathing apparatus], especially in a compartment with large open areas. When a lifeline is used, someone should monitor the line, using prearranged signals....
>
> Lifeline Signals...
>
Pulls on line		Meaning
	1	Are you all right?
Tender to	2	Advance.
Wearer	3	Back out.
	4	Come out immediately
	1	I am all right.
Wearer to	2	I am going ahead.
Tender	3	Take up my slack.
	4	Send help.

chief steward said that if he caught personnel smoking in the cargo hold, he would have them extinguish the cigarette and warn them that they would be disciplined if caught again.

All low temperature areas (the freezer holds and the freezer and processing decks) had extensive steel drain pipes to discharge water resulting from the defrost cycle of the refrigeration process. Electric heat tape to prevent freezing was spiral wrapped about six turns per pipe foot around the drain and the fire main pipes. The pipes and heat tapes were covered with a cellular plastic foam pipe insulation known as Rubatex.[11] The fire burned all thermal insulation from the drain lines as well as the electrical insulation from the heat tapes on the freezer and processing decks. The drain and fire main pipes in the burned-out refrigerated spaces could easily be identified because of the exposed spiraled double electric wires (bus wires) from the heat tapes.

The self-regulating heat tape is constructed with two parallel bus wires embedded in a carbon-filled semiconductor (matrix) material that allows current to flow between the bus wires. The current flow in the matrix generates heat. The matrix material conductivity changes (self-regulates) inversely with temperature. A flexible insulation covers the bus wires and carbon-filled matrix, and the tape is sold on a reel. The heat tape is cut from the reel, and the wire length determines the resistance: the longer the cable -- the lower the resistance -- the more electrical current drawn.

The three freezer holds had 10 evaporators suspended in their overhead space. Hold No.3 had four evaporators, one in each corner. A steel pan, fitted with an electrically heated pad to prevent water freezing, was under each evaporator to collect water during the defrost cycle. A 2-inch-diameter steel drain pipe, wrapped with electrical heat tape and covered with pipe insulation, drained water from the evaporator pan to a larger drain line that ran horizontally toward the aft end of the vessel. (See figure 7.)

The heat tape and thermal insulation covering the tape on the 2-inch-diameter drain pipe port side aft in hold No.3 was extensively fire damaged. This drain pipe was connected to the pan for evaporator No.1 that was in the overhead on the port side just aft of the elevator shaft and was also extensively fire damaged. The evaporator No.1 2-inch-diameter drain pipe, which was about 42 inches aft of the elevator shaft, ran vertically from the pan to a larger horizontal drain pipe on the deck. The center of the drain pipe was about 12 inches inboard from the hull, which had frames 8 inches deep and 26 to 27.5 inches apart. The pipe insulation was burned away with the bare bus wires from the heat tape remaining spiraled around the steel pipe drain line. (See figure 8.) The bare wires of the heat tape on this drain line were severed about 3 feet above the deck. The hull plating adjacent to this pipe and aft was more

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[11]Rubatex is the trade name of the Rubatex Corporation for the cellular plastic foam that is formed in long cylindrical hollow shapes to fit over pipes for thermal insulation. The Rubatex on the ALL ALASKAN was about 1-inch thick, and its inside diameter was dependent on the diameter of the pipe to be insulated.

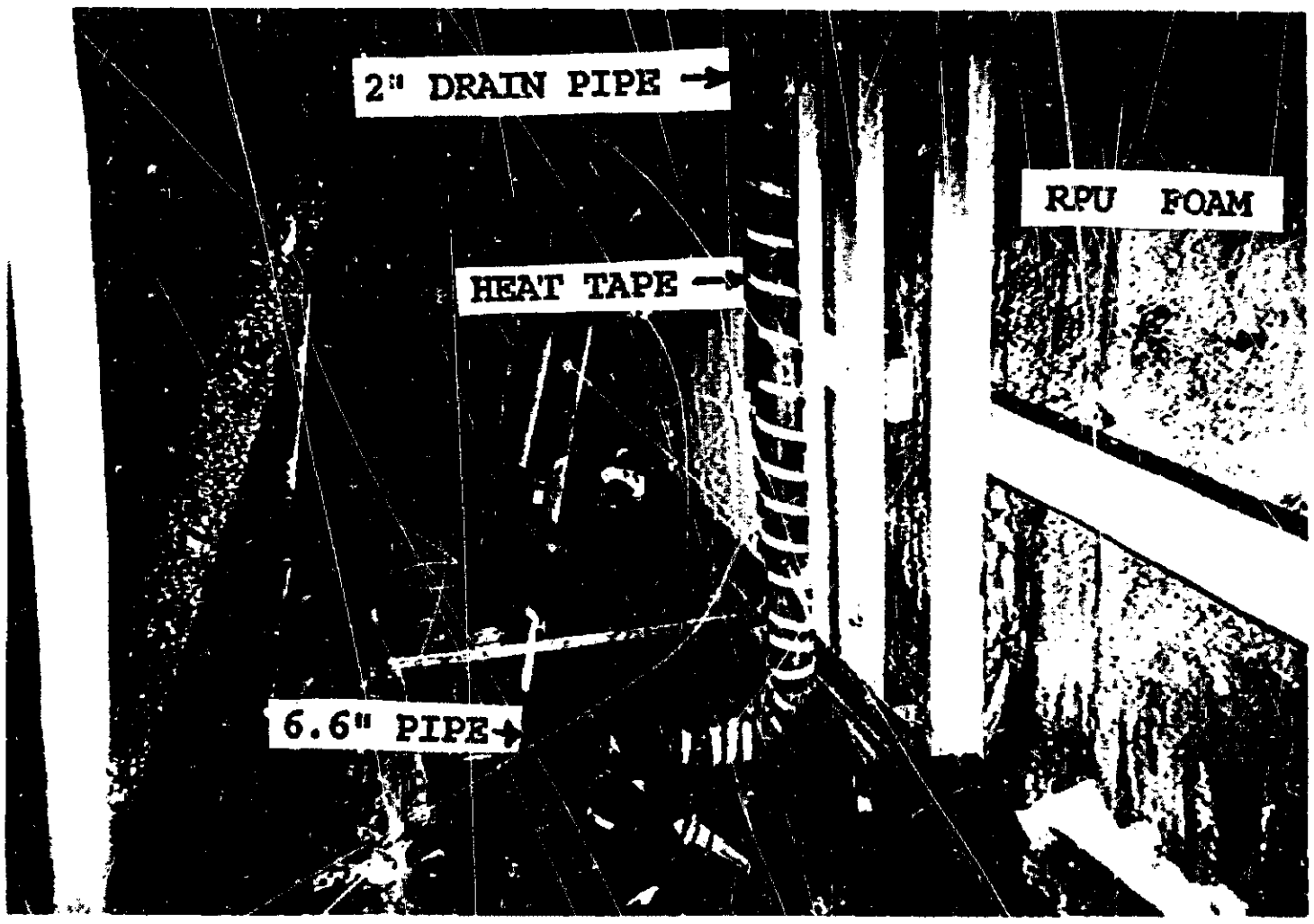


Figure 7 -- Typical installation of a heat tape-wrapped drain pipe with Rubatex pipe insulation removed.

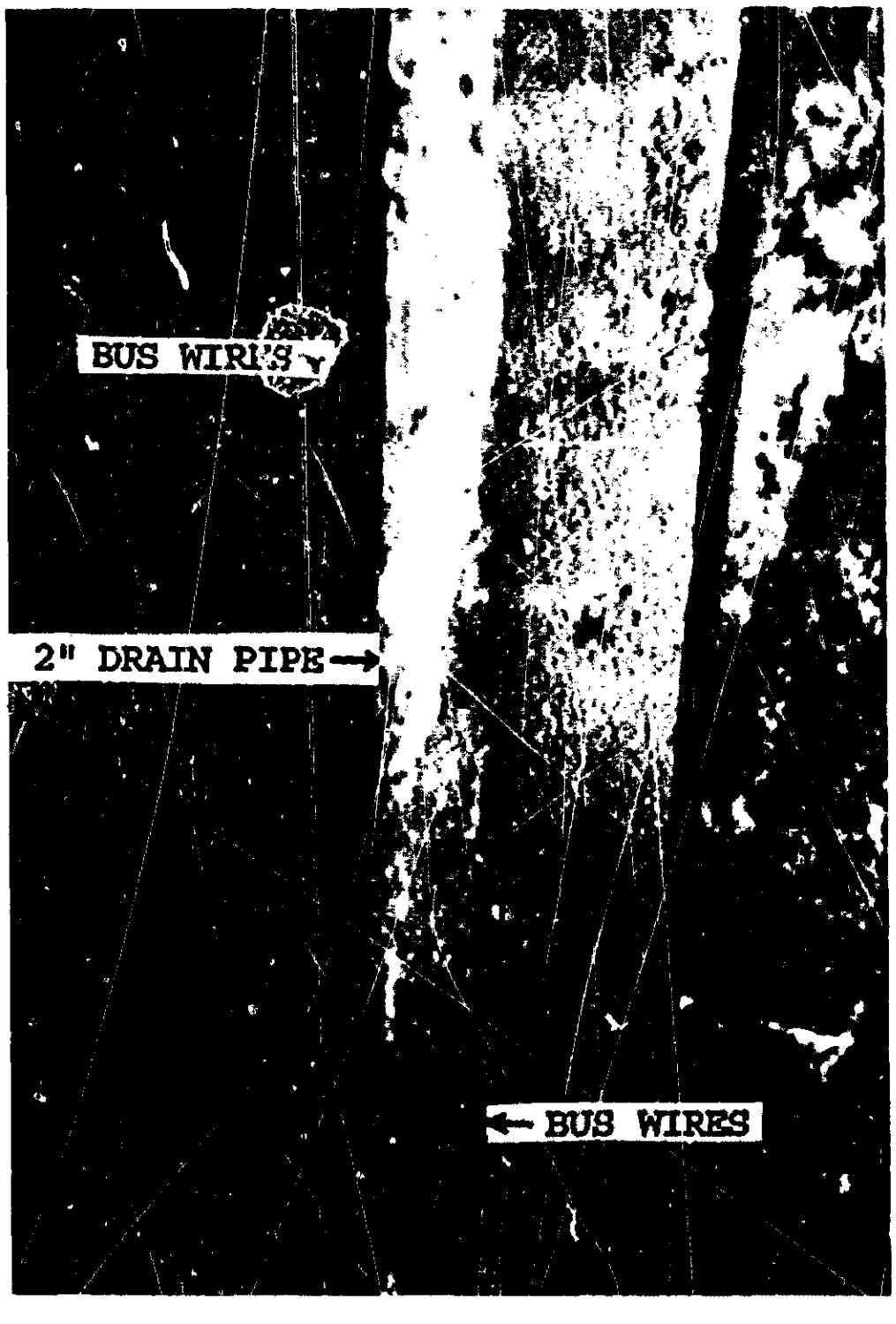


Figure 8 --Bare heat tape wire around drain pipe with all insulation burned away.

white in color than the other plating, which is consistent with exposure to intense heat. The RPU insulation on the hull aft of this pipe had been covered with 3/4-inch plywood sheathing that did not, however, cover the drain pipe because the space between the pipe and the two by fours attached to the hull frames was insufficient and was about flush with the plywood sheathing. (See figure 7.) Inspection of the corresponding drain pipe on evaporator No.2 showed that the Rubatex covering this drain pipe was next to and in some cases against the RPU foam insulation.

The broken ends of the heat tape wires taken from the drain line under evaporator No.1 were examined in the Safety Board's laboratory with an optical microscope. The examination of the stranded wires showed the ends to be melted with no obvious "beading" (melted with balled ends).

The second area which had heat tape damage was on a larger drain pipe in the hold No.3 aft port corner. (See figures 9 and 10.) This damaged tape was on a vertical 4.5-inch diameter pipe that was used to drain the sump area from the deck above and fed into a 6.6-inch diameter drain line that ran horizontally along the deck on the port side. The horizontal drain line covered with Rubatex was behind a concrete bulkhead (barrier) about 5.5 inches thick, 22 inches high, and 39 inches from the hull. A 3/4-inch thick plywood board covered the trough formed by the concrete barrier and the hull. The plywood extended from the elevator shaft aft and was destroyed by the fire. Examination of the drain pipe forward of the elevator shaft showed no RPU insulation sprayed in this trough.

A short section of the bus wires in the heat tape on the 4.5-inch pipe was exposed, severed, and appeared to have shorted about 7 inches from the tape end against the pipe where it is welded into the 6.6-inch diameter horizontal pipe. The damaged area was about 14 inches below the plywood covering the trough. The end cap[12] and about 5 inches of the tape insulation jacket were intact. (See figure 9.) Black electrical tape was wrapped around the jacket at the top of the end cap to insulate the bus wires and matrix material. The electrical insulation and matrix material were destroyed, exposing the bus wires, about 7 inches from the end cap; however, the failure did not extend for a complete turn around the pipe. Close inspection of the end cap, electrical tape, and insulation jacket below the bare bus wires showed that the matrix material underneath the electrical insulation was apparently burned away. An x-ray examination confirmed the missing matrix, the broken bus wires under the end cap, and the metal beads inside the end cap. Most of the Rubatex was intact with little fire damage around the tape failure area. The 6.6-inch diameter horizontal pipe was wrapped with heat tape and insulation and also had an electric-powered heat rod inside to keep drain water from freezing. The heat tape on the horizontal pipe, according to the AAS, was not energized.

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[12]The method of terminating the end of the tape and sealing the wires to prevent environmental contamination.

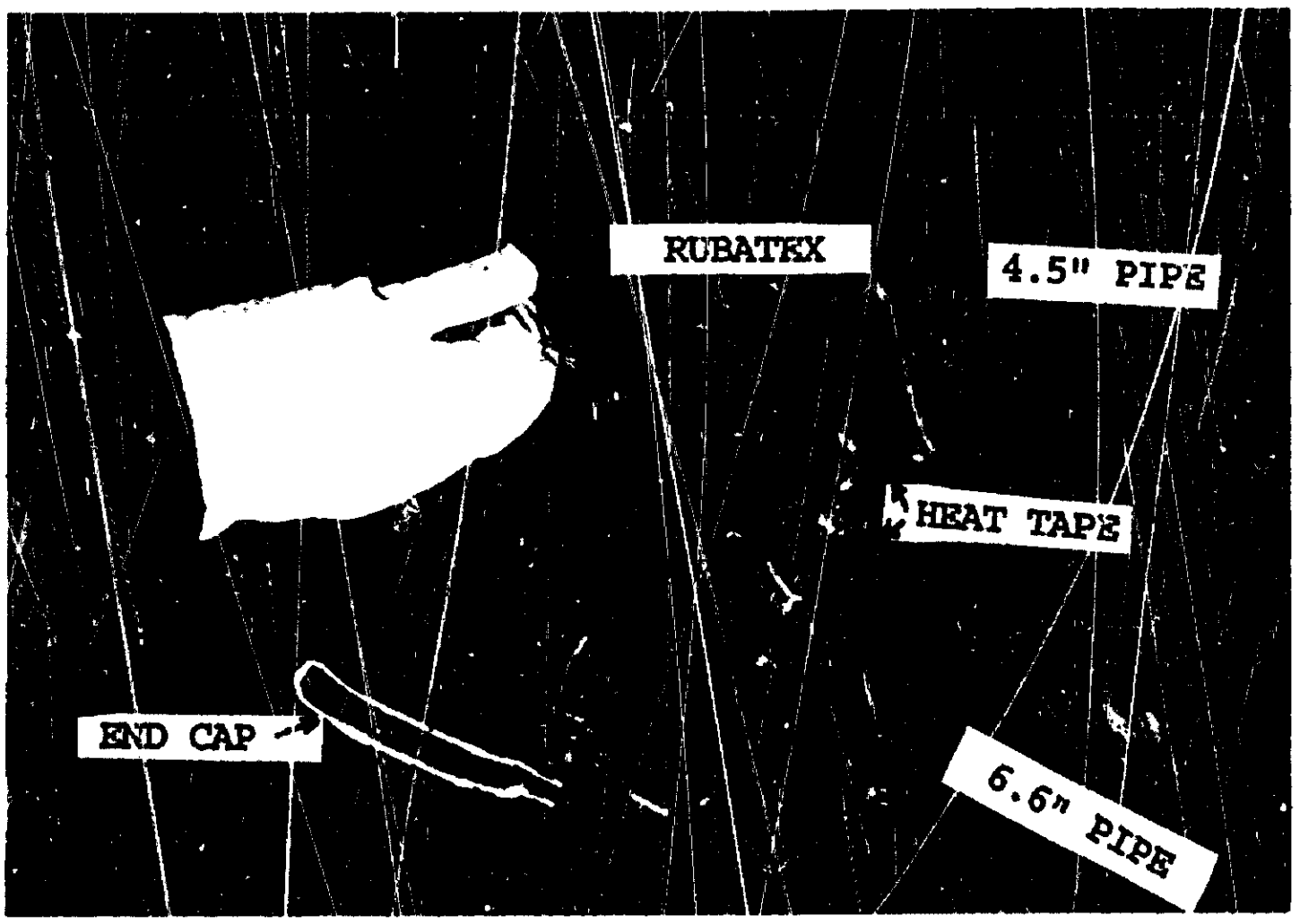


Figure 9 -- Photograph of drain pipe removed from cargo hold No.3 aft port corner.

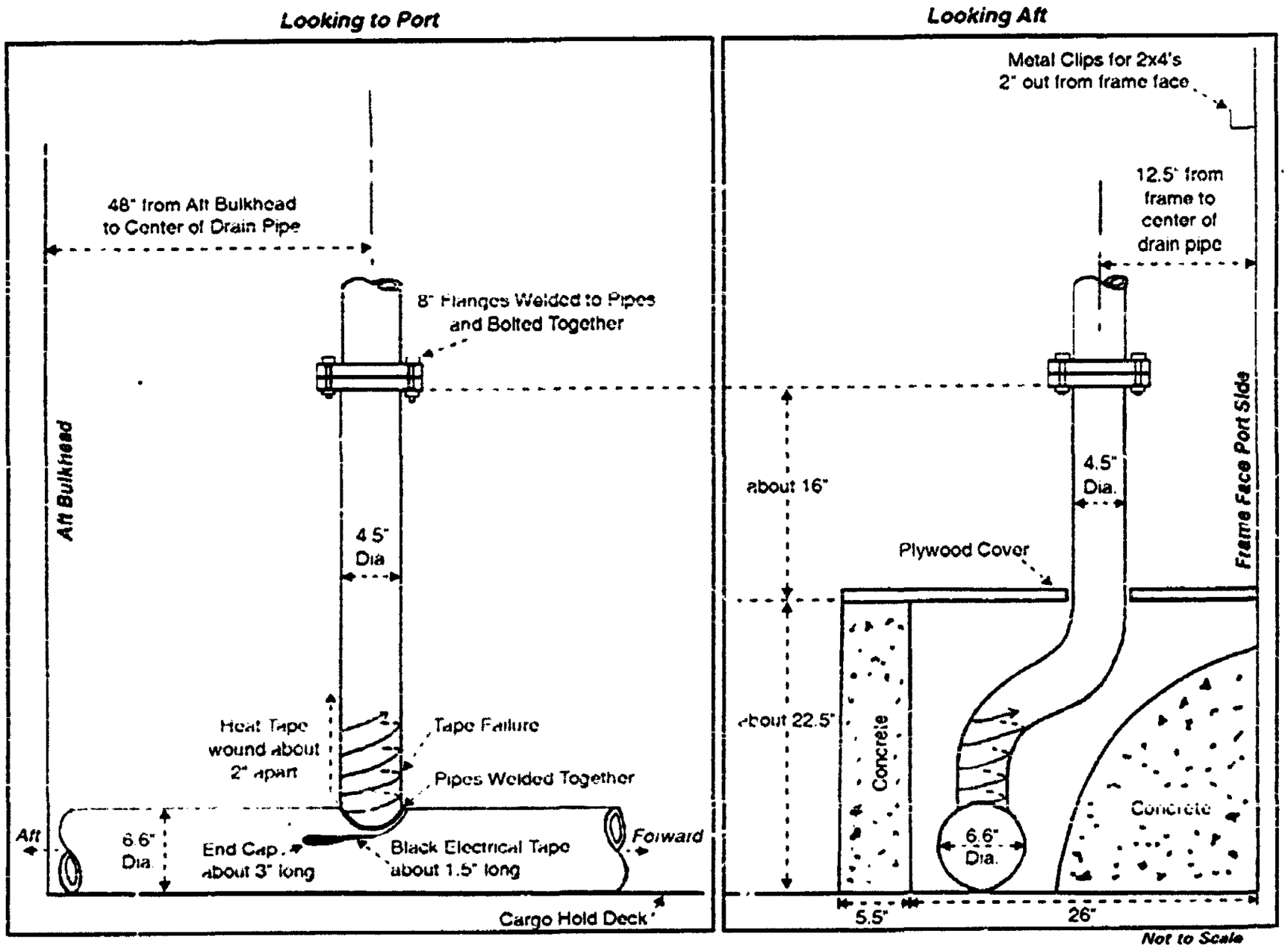


Figure 10 -- Illustration of drain pipe in cargo hold No.3 aft port corner.

The other three evaporator drain lines in hold No.3 and similar installations in hold No.2 were found intact without fire damage.

Three electrical control panels, one steel for the refrigeration equipment and two non-metallic (synthetic) for the heat tapes, were mounted on the forward bulkhead in the refrigeration machinery room aft of the freezer deck. The refrigeration equipment control panel with its overload relays survived the fire. Inspection of this panel showed that the overload relays for two of the three fan motors in evaporator No.1 in hold No.3 tripped before the electric power failed. It could not be determined when this occurred, but the relays do not trip when the power is off. The panel controllers showed that this evaporator was on the defrost cycle when the power failed. The heat and the fire destroyed the two heat tape control panels in the refrigerated spaces as well as the electrical components inside the panels.

A technical representative of Rubatex Corporation stated that the Rubatex Corporation does not recommend the use of a cellular plastic pipe insulation, such as Rubatex, over heat tape. It recommends that a noncombustible pipe insulation be used; however, the Rubatex literature does not state that Rubatex cannot be used with heat tape.

A section of undamaged heat tape, manufactured by Raychem Corporation, recovered from hold No.2 had a blue-colored flexible covering stamped "8XL-1, 120 volts ac, 8 watts per foot at 10 C, max. temp. rating 65 C, parallel self-regulating heat tape." Raychem provided information that showed the heat tape, taken forward of the burned area in hold No.3 on the 2-inch diameter pipe, was probably manufactured in 1989. Raychem also provided data sheets to the Coast Guard that contained instructions for the termination of the heat tape using an end seal kit, which were forwarded to the Safety Board. Investigators could not determine whether the heat tape on the No.1 evaporator drain line was terminated according to the instructions as the tape and termination hardware were destroyed in the fire or whether the ALL ALASKAN ever had such instructions. The 1990 Raychem *Installation Instructions for Power Connection with End Seal Kit* warns, "Use fire resistant insulation materials such as fiberglass indoors and under buildings [when covering heat tape]." Safety Board investigators requested the AAS records documenting heat tape purchases to determine whether installation instructions were received before the tape installation. The company was unable to provide these records; however, it reported that the heat tape had been installed between 1988 and 1989 during the vessel conversion. The electrician testified that the heat tape had been installed when the holds were converted and the evaporators were installed.

Test and Research

Electrical Heat Tape -- The U.S. Consumer Product Safety Commission (CPSC) has been concerned about the safety of electric heat tapes used to prevent residential water pipes from freezing. The CPSC reported that the national fire data for 1985 through 1987 show 3,300 residential fires, 20 deaths, 160 injuries, and $25.4 million in property losses annually from

electric heat tapes.[13] As a result of its concern, the CPSC contracted two safety studies[14] in which consumer-available electrical heat tapes (resistive and self-regulating types) intended for residential installation were tested. Three of the self-regulating heating tapes tested were similar, but not identical, to the type used on the ALL ALASKAN.

Both CPSC studies concluded that the self-regulating heat tapes present a potential fire hazard when connected without a fuse and a ground-fault current interrupter (GFCI). The 1994 study determined that a 30-ampere branch circuit breaker or fuse did not provide fire protection when the heat tape failed; however, a 10-ampere fuse did allow some protection but did not have 100-percent reliability as a safety measure. The GFCI was very effective at eliminating the fire hazard when the heat tape was covered with an electrically grounded metal braid.

The Raychem *Auto-Trace "R" Heat-Tracing Systems for Ordinary and Hazardous Division 2 Locations; Installation and Maintenance Guide* (published after 1990) advises about fire and shock hazards: "To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, use a ground-fault protection device (GFPD). Arcing may not be stopped by conventional circuit breakers." The guide warns "Do not use vinyl electric tape [for heat tapes]....Do not use vinyl based tapes. Some vinyl tapes (electrical or duct tapes) can reduce the operating life of heating cables."

The Safety Board tested heat tape provided by Raychem and heat tape from the ALL ALASKAN at Underwriters Laboratories Incorporated in Chicago, Illinois. (See appendix C.) The testing was conducted to determine the relevance of the CPSC studies for the residential shoreside to the commercial heat tape used on vessels and to demonstrate the heat tape behavior when it fails. The tape, tested without end-seal terminations and in the horizontal position, was electrically powered as on vessels and had salt water dripping on its exposed terminal end until arcing and ignition of its jacket occurred. Various salt water concentrations were used; however, to facilitate failure in a reasonable time period, salt concentrations higher than sea water were used to cause repeated failures of the heat tape. Arcing around the bus wire was first noted as the salt water wet the bus wires and the matrix material. Time to ignition of the heat tape was dependent on the salt water concentration. Flaming took about 20 minutes when the concentration of salt water was about 200 grams/liter,[15] and the flames moved along the tape towards the power source and extinguished when electrical power was terminated.

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[13]Sheila Kelly, *Product Sketch: Electric Heat Tapes*, U.S. Consumer Product Safety Commission, Directorate for Epidemiology, January 1990.

[14]*Heat Tape Safety*. Contract No.CPSC-C-86-1161, Task Order No.10, Met Report No.18709N-88, June 10, 1988; *Report on the Heat Tape Safety Contract*. Contract No.CPSC-C-93-1126, March 1994.

[15]The concentration of sea water is about 35 grams/liter.

A 30-ampere protection device was built into the testing circuit from which the test heat tape was powered. In no experiments in which the heat tape arced and ignited did the current exceed the circuit breaker rating to stop current flow to the tape, and power had to be manually secured. The test results were consistent with the CSPC findings: a fuse and/or circuit breaker was not a reliable protection against arcing and ignition of material wrapped around the heat tape when a tape failure occurs. No regulations or national marine safety standards exist for heat tape installation and use on vessels.

Rigid Polyurethane Foam Insulation -- In the 1960s and early 1970s, RPU foam insulation was advertised as self-extinguishing and nonflammable and was used extensively as thermal insulation in shoreside structures. In some instances, the RPU foam was involved in fires during the construction phase.[16] The RPU foam flammability and its associated hazard is best demonstrated by the full-scale room studies conducted by various investigators.[17] In the 1973 report by W.F. Marconi, the room was completely lined with 1 1/2-inch-thick RPU foam with a flame-spread index of 200 when tested in accordance with the American Society for Testing Materials (ASTM) E84.[18] The wall and ceiling lining was ignited from a source in the room corner. The fire spread rate in this experiment exceeded the response rate of the automatic sprinkler system. In the 1986 Swedish study, a room was covered with various materials, including RPU foam, and ignition also initiated in the room corner. The time to a flash over was one parameter measured: 6 seconds when the room was lined with RPU foam compared with 157 seconds when lined with wood particle board.

As a consequence of the high flammability of plastic foam insulation, the U.S. model building codes (shoreside) were modified in 1976 to limit the use of cellular plastic material. The three major national model building code groups are the International Conference of Building Officials (ICBO), the Southern Building Code Congress International, Inc. (SBCCI), and the Building Officials and Code Administrators International (BOCA), and each publishes a building code. The BOCA, the SBCCI, and the ICBO publish the National Building Code (NBC), the Standard Building Code (SBC), and the Uniform Building Code (UBC), respectively. Each code group is a consensus body, having some degree of uniformity among their model codes, although different regional and geographical needs are met in the different

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[16]George H. Paul, Edward V. Clougherty, and James K. Lathrop, "Federal Reserve Bank-Fire in Exposed Urethane Insulation in Building Under Construction," Boston, Massachusetts, *Fire Journal*, pp. 33-55, July 1977.

[17]W.F. Marconi, *Large-Scale Fire Tests of Rigid Cellular Plastic Wall and Roof Insulation*, Fire Journal, pp. 24-26, November 1973; B. Sundstrom, *Full-Scale Fire Testing of Surface Materials*, Technical Report SP-RAPP 1986:45, Swedish National Testing Institute, Boras, 1986.

[18]The standard test method developed by the ASTM that exposes a 24-foot by 20-inch specimen and measures flame spread rate and smoke development. The material rating (flame spread index) and smoke number are obtained from a comparison with the flame spread rate and smoke development of red oak. The flame spread for shredded wood fiberboard (treated with flame retardant), gypsum board (with paper surface on both sides), and red oak (untreated) is -20 to 25, -10 to 25, and -100, respectively.

code groups. These three model codes require that foam plastic insulation meet certain fire protection requirements before it can be used. It should have flame spread and smoke development ratings of not more than 75 and 450, respectively, when tested in accordance with ASTM E84. In addition, its use on roomside surfaces either must be protected (covered) by a thermal barrier equal in fire resistance to 1/2-inch gypsum board or only be in buildings that have sprinklers.[19] Both requirements pertain to foam more than 4 inches thick.

The high flame spread rate of RPU foam is attributed to the relatively low decomposition temperature (about 325 °F) and the high smoke emission rate (combustible gases). Exceptions to the thermal barrier requirement, designed to protect the foam from ignition, are granted in certain cold storage facilities. The three model codes require an approved automatic fire suppression system in cold storage rooms and buildings. Two codes require that RPU insulation must be covered with at least 0.032-inch-thick aluminum or at least 0.016-inch-thick corrosion resistant steel; the third code allows exposed RPU. No code requires automatic sprinkler systems for free-standing walk-in cooler and freezer units of less than 400 square feet.

Olfactory Sense -- The refrigerated cargo hold where the fire originated had a temperature about -26 °F. During the investigation, the question of what effect, if any, extremely cold temperatures have on the sense of smell was asked. A review of available scientific literature on olfaction disclosed no specific answer. Safety Board investigators then contacted several olfaction researchers for their opinion about the effects of temperature on the ability to detect odors. Some researchers stated that ambient air temperature should not adversely affect the ability of noxious[20] molecules, which remain unchanged once released into the atmosphere, to reach smell receptors in the nose. One researcher[21] stated that the nose warms and humidifies the air surrounding the receptors at essentially a constant rate. Therefore, smell receptors would be unaffected by the ambient temperature and humidity. Another researcher[22] said because vapor pressure is a function of temperature, the lower the ambient air temperature, the lower the vapor pressure. The results would be reduced vaporization occurring in the environment that would decrease the number of molecules traveling through air. Such atmospheric conditions, however, would have no effect on the ability of a molecule to be detected once it reached the receptors.

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[19]Model code provisions pertaining to foam plastics insulation, The Society of Plastics Industry, Inc., 1990.

[20]Denotes the ability to detect but not necessarily identify particular odors when a molecule comes into contact with a smell receptor. The term does not necessarily indicate poisonous.

[21]Dr. Richard Doty, Director, Smell and Taste Center, University of Pennsylvania, on January 10, 1995.

[22]Dr. George Preti, Monell Chemical Senses Center, Philadelphia, Pennsylvania, on February 15, 1995.

Fish Processing Vessels

Coast Guard Regulations - The "Requirements for Commercial Fishing Industry Vessels"[23] are found at 46 CFR part 28, subchapter C (Uninspected Vessels). Subpart 28.100 requires that uninspected commercial fishing industry vessels must also meet the requirements of General Provisions, Equipment Requirements, and Operations in parts 24, 25, and 26, respectively. Section 28.710(a) additionally requires that once every 2 years an uninspected fish processing vessel must be examined for compliance with subchapter C and certified in writing by the American Bureau of Shipping (ABS), a similarly qualified organization, or a surveyor of an accepted organization.[24] Because fish processing vessels "of not more than 5,000 gross tons" are exempt by law[25] from Coast Guard inspection, the ALL ALASKAN at 4,875 gross tons was an uninspected vessel.

Vessels built or converted on or after September 15, 1991, are required to have a fixed-gas fire-extinguishing system in a space, excluding cargo holds, that contains an internal combustion engine of more than 50 horsepower, an oil-fired boiler, an incinerator, or a gasoline storage tank. A surveyor from the ABS examined and found the ALL ALASKAN to be in compliance with the appropriate regulations on December 30, 1993. He certified that the vessel had all regulation-required lifesaving, firefighting, navigation, and other safety equipment.

Coast Guard regulations for inspected vessels specifically prohibit combustible construction, including organic foams into which category polyurethane falls, in most living and working spaces. However, these regulations do not apply to cargo holds and certain machinery spaces on inspected vessels. The same rules apply to fishing industry vessels (46 CFR 28.380[e]) in which insulation must be noncombustible except in machinery spaces for pipe and machinery lagging and in cargo holds and refrigerated compartments of service spaces. The international regulations, Safety Of Life At Sea Convention of 1974 (SOLAS 74) chapter II-2, part C, for cargo vessels specifically prohibit combustible construction in living and working spaces except for cargo holds and refrigerated compartments of service spaces.

On April 29, 1980, the Coast Guard issued Navigation and Vessel Inspection Circular (NVIC)[26] No. 8-80 (Fire Hazard of Polyurethane and Other Organic Foams). Its stated purpose was "to alert vessel inspectors, designers, builders, and operators of the potential fire

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[23]Effective August 14, 1991, as a result of The Commercial Fishing Industry Vessel Safety Act of 1988. Public Law 100-424.

[24]Designated by the Coast Guard to examine commercial fishing industry vessels and to comply with the requirements of 46 CFR 28.73.

[25]Title 46 USC 3302(c)(1).

[26]Recommended policy, requirements, procedures, or guidance published for Coast Guard marine safety personnel and the marine industry.

hazard of polyurethane and other organic foam materials [because of] serious fires [on] several ships." These guidelines, intended to apply to all vessels, also state that:

> when organic foams (including those described as self-extinguishing, nonburning, fire resistant, flame resistant, and similar terms) are exposed to fire or heat, they may ignite and burn with rapid flame spread, high temperatures, toxic gases, and voluminous quantities of smoke.

The NVIC recommends that whenever polyurethane or other organic foam materials are installed, a covering of 22 United States Standard Gauge steel (about 1/32 inch thick) or other suitable noncombustible material with at least a 15-minute fire rating be installed over the foam insulation. The ALL ALASKAN had used RPU insulation in the holds, freezer deck, and processing deck; however, it was not covered with a noncombustible material, nor was it required to be.

The Coast Guard issued NVIC No. 5-86 (Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels) on August 18, 1986, that was "[i]n response to the poor safety record of uninspected commercial fishing vessels...." NVIC 5-86[27] refers to NVIC 8-80 and also recommends that insulation fitted in refrigerated compartments and fish holds should be noncombustible unless the exposed surfaces are protected. NVIC 5-86 recommends that smoke or fire detection systems should be installed to indicate the presence and location of fire or smoke in galleys, accommodations and other high risk spaces and that cargo holds with a high-fire risk should be protected by a fixed carbon dioxide fire extinguishing system.

Three Worcester [Massachusetts] Polytechnic Institute (WPI) students, in cooperation with the U.S. Coast Guard Headquarters Marine Technical and Hazardous Materials Division, prepared the October 1990 *Unclassed Fish Processing Vessel Study*[28] in which they examined and discussed factors affecting safety aboard fish processing vessels. The report concluded that polyurethane insulation "has been shown to consistently contribute to fires aboard fish processing vessels" and that a suitable substitute be found for polyurethane foam insulation.

Coast Guard Oversight -- The Coast Guard revised its implementation policies of the commercial fishing industry vessel regulations on August 13, 1993, to educate the fishermen, encourage compliance with the regulations, and discourage unsafe operations. Owners of uninspected vessels can voluntarily have the vessels examined at dockside by the Coast Guard, a qualified organization such as the ABS, or a surveyor of an accepted organization to ensure

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[27]Chapter 3 (Fire Safety Measures), section J (Foam Insulation).

[28]This report was in partial fulfillment of the WPI college degree requirements.

that the vessel meets the requirements for uninspected vessels in 46 CFR subchapter C. The vessel receives a year-dated decal that has no expiration date if it passes inspection. Vessels with decals less than 2 years old will not normally be reexamined within that period. Should a vessel with a decal be boarded by the Coast Guard at sea, the decal would signify to the boarding officers that the vessel passed a dockside examination and only a limited at-sea examination is necessary.

Those uninspected vessels that are required to be examined for compliance by a qualified organization such as the ABS are not normally examined by Coast Guard personnel. The ALL ALASKAN fit this category and was required to be ABS-examined every 2 years; however, a limited at-sea examination could be carried out by Coast Guard boarding officers in conjunction with their search and rescue, fisheries management, and law enforcement boarding patrols.

Inspected Vessels -- When a vessel is being built or converted for fishing industry use, the Coast Guard examines the vessel plans, monitors construction, and performs a final inspection, after which the vessel is issued a certificate of inspection (COI). The COI contains the applicable vessel information, the route authorized, the equipment required, and the crew operating levels. These vessels are inspected on a 2-year cycle, which also includes the drydocking inspection.

Operations -- For fish processing vessels not required to have a Coast Guard certificate of inspection, the operating requirements are:

- o two-watch system[29] for licensed officers (master, chief mate, chief engineer, and assistant engineer) and deck crew.

- o certificated lifeboatmen are not required for the primary lifesaving (liferafts and lifeboats) equipment.

For fish processing vessels required to have a Coast Guard certificate of inspection, the operating requirements are:

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[29]No more than 12 hours of watch/regular duty in a 24-hour period.

- three-watch system[30] with master, chief mate, second mate, third mate, six ABs, three ordinary seamen, chief engineer, first assistant engineer (AE), second AE, third AE, and three engine maintenance seamen.

- certificated lifeboatmen are required for the primary lifesaving equipment (one for each liferaft and lifeboat). These lifeboatmen are usually the licensed officers and the ABs.

Coast Guard-licensed masters, mates, and engineering officers on vessels of over 200 gross tons (also operators of uninspected towing vessels with ocean licenses and licensed persons on mobile offshore drilling units) are required to complete basic and advanced firefighting courses that meet sections of the International Maritime Organization Resolution A.437, Training of Crews in Firefighting. Coast Guard-approved firefighting courses meet the international recommendations.

History -- Most at-sea fish processing before 1980 was accomplished by foreign vessels. The Magnusen Fisheries Conservation and Management Act (MFCMA) of 1976 authorized the Federal Government to conserve and manage all fishery resources, except tuna, within the U.S. fishery conservation zone, which extends 200 miles from the United States and its territorial coasts. Between 1976 and mid-1985, most U.S. fishermen brought their catch to foreign processing vessels; however, this procedure phased out as the U.S. processing vessels increased in number. The U.S. fishing fleet currently consists of approximately 130,000 vessels, including about 250 fish processing or combination fishing/fish processing vessels. Approximately 50 fish processing and 76 combination fishing/fish processing vessels are over 79 feet.[31] The 635.5-foot, 17,845-gross-ton OCEAN PHOENIX is the only fish processing vessel required to be inspected by the Coast Guard.

Vessel Fire Protection Rules -- A comparison of the fire protection requirements for uninspected fish processing vessels with the fire protection requirements for cargo, oceanographic research, and international cargo vessels is summarized in the following table.

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[30]No more than 8 hours of watch/regular duty in a 24-hour period, normally 4 hours on duty and 8 hours off duty.

[31]*Fishing Vessels of the United States 79' and Over*, Nautilus Publishing Company, Seattle, Washington, 1994.

Table 1. Summary of Fire Regulations for Various Types of Vessels

	Uninspected Vessels & Fish Processing Vessels	Inspected Cargo Vessels	Inspected Oceanographic Vessels	International Rules for Cargo Vessels
Fire Protection	46 CFR 25 & 28	46 CFR 95 & 97	46 CFR 193	SOLAS 74 as amended for cargo vessels
Portable Extinguishers	Required.	Required.	Required.	Required.
Semiportable Extinguishers	Required.	Required.	Required.	Required.
Fixed Fire Extinguishing System	Required for vessels over 79 feet or more in length in a space containing an internal combustion engine of more than 50 HP, an oil fired boiler, an incinerator, or a gasoline storage tank.	Required in cargo compartments and tanks for combustible cargo (explosives, vehicles, or combustible liquids), paint lockers, engine spaces on vessels 1,000 GT and over and with main and auxiliary engine power of 1,000 HP or greater.	Required in cargo compartments and tanks for combustible cargo (explosives, vehicles, or combustible liquids), paint lockers, engine spaces on vessels 1,000 GT and over and with main and auxiliary engine power of 1,000 HP or greater; also, there are specific requirements for spaces containing explosives and other dangerous articles or substances used in research.	Required in cargo compartments and tanks for combustible cargo, paint lockers, engine spaces on vessels 1,000 GT and over. Cargo spaces may be exempt for noncombustible cargoes.
Fire Detection	Required that each accommodation space must be equipped with an independent modular smoke detector or a smoke actuated fire detecting unit in accordance with 46 CFR 76.33 for inspected passenger vessels.	Not required, but if installed must meet 46 CFR 76.33 for inspected passenger vessels.	Not required, but if installed must meet 46 CFR 76.33 for inspected passenger vessels. However, compartments containing explosives or capable of carrying vehicles must have a smoke detecting or other suitable fire detecting system.	Required in accommodation spaces and in certain type of construction. Galleys and other service spaces must also be protected.
Supervised Fire Patrols Systems	Not addressed.	Nothing in this part shall exonerate any master of any neglect to...maintain a proper fire watch or from any neglect of any precaution which may be required by the ordinary practice of seaman or by the special circumstances of the case.	Not required, but if installed must meet 46 CFR 76 for inspected passenger vessels.	Not addressed.

Reported Accidents -- For the 126 fish processing and combination fishing/fish processing vessels over 79 feet, Coast Guard records indicate 69 reported and investigated vessel accidents[32] between 1984 and 1991. Fifteen of these accidents involved fires; 10 fires were in the engineroom or related to electrical problems. Coast Guard records between 1992 and 1994 show 26 vessel accidents of which 6 involved fires;[33] however, the 1994 records are incomplete because some investigations remain open and computer files are being loaded.

From January 1988 through February 21, 1994, the ALL ALASKAN had 21 personal injury cases and a fire that occurred on December 26, 1988, while the vessel was undergoing structural modifications alongside a Tacoma, Washington, dock. As a result of the fire, two men died, and the vessel damage was $1.5 million. The Coast Guard indicated in its report that the fire started when hot slag from a cutting torch ignited the RPU foam insulation; however, it made no recomendations to the AAS.

In addition, the chief steward testified that he recalled a small fire, which was quickly extinguished, in one of the trailer housing units aft. He could not remember the date but said it "was a while ago" and he had been employed about 5 and 1/2 years on the ALL ALASKAN. The electrician also testified that at the end of the crab season about March 1994, a heat tape on the starboard fuel dock piping on the main deck was sparking like a "dynamite fuse" and continued until the power was shut off. He added that during the 1994 salmon season (May, June, and July), a heat tape failed on the freezer deck, when salt water apparently penetrated a splice, and was "burning." He shut off the power to stop the burning. He further testified that he had no electrical problems in the cargo holds.

The AAS-owned barge NORTHERN ALASKAN while processing in Magadan, Russia, experienced a heat tape failure on November 19, 1994, that resulted in a fire, which the company termed a minor incident. Heat tape on a water pipe on the top deck failed apparently from a crack in the tape.

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[32]Title 46 CFR 4.05 defines accident/casualty as a grounding; a loss of main propulsion or primary steering or any associated component or control system; an occurrence that adversely affects the vessel such as fire, flooding, failure of fixed fire extinguishing systems, life saving equipment, auxiliary generating equipment, or bilge pumping systems; a loss of life; an injury that requires professional medical treatment beyond first aid; a person unfit to perform routine vessel duties; or an occurrence not meeting the above that results in damage to property in excess of $25,000. (Note: The damage amount over the years has gradually increased to its present amount.)

[33]Between 1991 and 1992, the Coast Guard changed its computer hardware and software and used a different format for its accident records. Also, the regulations for commercial fishing industry vessels effective August 14, 1991, increased the emphasis on personal injury reporting.

The fish processing vessel AL-IND-ESK-A-SEA[34] caught fire and burned in 1982 while laying at anchor in Everett, Washington. The Safety Board determined the probable cause of the fire to be the failure of the crew to cool the hot metal that allowed the highly flammable polyurethane insulation to ignite. (The crew used a gas torch to cut the metal bulkhead.)

The OMNISEA, another cargo vessel converted to a fish processor, caught fire and burned in 1991 while undergoing repairs and modifications pierside in Seattle, Washington. According to the Coast Guard investigation report, a welding crew working on the second deck near a cargo hold left their equipment unattended when they went on break. The RPU foam insulation caught fire, spreading through the insulated reefer holds through open doors and hatch openings. A crewmember noticed smoke in the area and notified the other personnel aboard. The crew tried unsuccessfully to extinguish the fire before calling the Seattle fire department. The thick black smoke and toxic fumes produced by the burning RPU foam prevented penetration of the holds by the firefighters. The fire department sealed the holds, introduced 500,000 pounds of carbon dioxide to extinguish the fire, and used fire hoses to cool the external surfaces. The fire burned for 3 days before it was extinguished.

In November 1994 at dockside in Seattle, Washington, a fire occurred on the fish processor YARDARM KNOT during repair work in the processing area. Coast Guard investigators determined that the fire started as a worker cut steel with a gas torch and sparks ignited RPU foam insulation on an adjacent bulkhead. The estimated damage was $775,000.

The above fire incidents, which occurred on fish processing vessels, were in foam installations that were not regulated. The involved vessels were uninspected and not required to meet any national marine safety standard for RPU insulation and other organic combustible insulating materials for vessels.

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[34]Marine Accident Report--Brief Format Issue Number 1 (NTSB/MAB/84/02).

ANALYSIS

General

The weather at the time of the accident was clear with light winds and visibility between 10 and 15 miles. The seas were calm with 2-foot waves and a 4-foot ground swell. The propulsion, steering, refrigeration, and navigation equipment functioned properly before the fire. The Safety Board therefore eliminated the weather conditions and the vessel mechanical systems as factors in this accident.

In this analysis, the Safety Board has examined the ignition source, the RPU insulation use, the fire watch procedures, the fire team firefighting training, and the toxicology issues.

Ignition Source

The fan motors on the evaporators aft, the heating pads on the drain collector pans under these evaporators, and the electric circuits (other than heat tape circuits) in hold No.3 and lighted tobacco materials were considered and eliminated as ignition sources. The burn pattern eliminated the first three items considered because the RPU insulation on the overhead and the Rubatex on the piping were smoke damaged and charred but not destroyed. Had the ignition initially occurred in this overhead area, the insulation would have been destroyed, and the flame probably would not have spread down to the deck. In addition, the Rubatex, covering the drain pipe connected to the collector pan with the heating pad, was heat damaged but still intact and not burned. Any discarded smoking material, such as a burning cigarette, was not considered a feasible ignition source because it would have had to smolder for 8 1/2 hours, which is a very unlikely possibility. Also, the odor was described as unusual, and a smoldering cigarette smell would probably have been recognized as such. Finally, Safety Board investigators found no evidence after the fire of smoking in the hold.

The burn pattern on the vessel indicated that the lowest point of the fire was in hold No.3 on the port side aft of the elevator. The plywood covering and the sprayed-on RPU insulation on the hull from the elevator to the aft bulkhead were completely burned. The hold No.3 aft area was also where the "strange smell" was reported during various times in the 8 1/2 hours before the fire. Two potential ignition points were identified during the investigation in this area of the vessel as likely ignition sources, based on the burn pattern and other evidence.

The first potential ignition source for the fire was the heat tape on the 2-inch diameter vertical drain pipe from the No.1 evaporator in hold No.3. The Rubatex, the electrical insulation on the heat tape, and the semi-conducting material between the heat tape conductor wires were burned. The heat tape bus wires remained spiraled around the pipe and were separated about 3 feet above the deck. A whitish area, consistent with a hot spot, was noted on the hull behind the

pipe. The ends of the bus wires did not appear to have been cut but were severed and rounded consistent with electrical shorting and failure under power.

Because the end cap and all insulation were destroyed, the Safety Board could not determine whether the heat tape failed at the end cap. The proximity of the drain pipe to the loading and unloading activities near the elevator subjected it to possible mechanical damage and failure particularly because the plywood protection did not extend over the drain pipe. Because the drain line was insulated with Rubatex that was close to the RPU insulation, the fire could have easily spread into the foam.

The second potential ignition source was another heat tape in the port corner aft of hold No.3 that was wrapped on a 4.5-inch-diameter vertical pipe. The failure was behind a concrete barrier about 26 inches from the hull frame face forming a trough covered with plywood sheathing and about 14 inches below the plywood cover. The tape end cap and about 5 inches of the electrical insulation jacket above it were intact. Above this area, the bus wires were exposed and separated. Much of the Rubatex pipe insulation was still intact, although some insulation was burned. The electrical insulation and the heat tape matrix were burned away only at the failure site; however, about 2 inches above this failure, the heat tape spirals were undamaged. The failure appears to have taken place under power because the wire ends are beaded and metal beads/fragments were in the end cap. This failure site could have been the ignition source for the fire, although a number of factors suggest otherwise. First, the tape failed at the termination and did not progress for a complete turn around the pipe. Second, a 2-inch turn of heat tape above the failure site indicates that the fire did not spread upward, a typical mode of fire spread. The heat tape above the 2-inch spiral should have been burned if ignition had occurred here. Third, the Rubatex, which had to be removed to uncover the failure site, would have been consumed if the fire had started there. Fourth, except for the still-present Rubatex, the closest combustible material, the plywood, is about 14 inches above the failure site. Consequently, without direct fire spread upward to the plywood at this location, an easy route for the fire to spread into the RPU foam does not appear to exist.

Because the concrete barrier and the plywood cover protected the heat tape from mechanical damage, it is probable that the tape failed at its end cap, which most likely occurred from salt water leakage into the end cap. The x-ray analysis of the end cap showed copper beads and broken wires, and the electrical tape wrapped at the end seal indicates that a repair was made to the heat tape or end seal. The use of electrical tape, according to the 1990 Raychem guide, is not an appropriate method of repair. From this evidence, an improper repair and/or installation of the end cap appears to have allowed sea water to enter the end cap, which led to the failure.

Furthermore, the tape seems to have failed while the end cap and a short length of the tape were under water. This supposition would explain the unburned end cap, unburned electrical tape, and short length of good electrical insulation with the semi-conducting heat matrix burned away. The experimental results of tape taken from the vessel and a new tape show that when the bus wires are to the matrix, the matrix heats up and the system ignites. Water had

accumulated on the aft port side of the vessel at various times. The chief steward testified that ice had to be chipped out after fish processing cleaning procedures and that he believed the water came down the elevator shaft. Thus, salt water most likely accumulated around the drain pipe and entered the end cap leading to an electrical failure. This evidence shows that the tape had failed some time earlier and, thus, was not the ignition source for this fire.

All evidence indicates that the fire originated in hold No.3. The RPU foam insulation in contact with the Rubatex pipe insulation and heat tape on the 2-inch diameter vertical drain pipe allowed the fire to spread directly into the RPU foam. Thus, the Safety Board concludes that the ignition source for the fire was the failure of the heat tape on the 2-inch diameter vertical drain pipe in hold No.3 on the port side aft. In addition, had the RPU foam insulation in hold No.3 been physically separated from the heat tape failure by a noncombustible material, the fire may not have occurred. Therefore, the Safety Board believes that the Coast Guard should amend 46 CFR 28 subpart D to require that equipment using heat tape be physically separated from RPU foam and other organic combustible material insulations by a noncombustible material. The Safety Board also believes that the AAS should inspect its fish processing vessels that use heat tape to ensure the heat tapes are physically separated from RPU foam and other organic combustible material insulations by a noncombustible material. In addition, the Safety Board believes that the Commercial Fishing Industry Vessel Safety Advisory Committee (CFIVSAC)[35] should advise fishing vessel owners to inspect their vessels that use heat tape to ensure the heat tapes are physically separated from RPU foam and other organic combustible material insulations by a noncombustible material.

The electrical distribution circuits on marine vessels are generally designed to be ungrounded. On a steel-hulled ship that uses an ungrounded distribution system (no neutral conductor), a grounding of either heating tape conductor may not cause the circuit-over-current protecting device to disconnect and, ironically, a disconnection is more likely if the electrical system is in good condition. However, should the system have poor electrical insulation or another accidental ground on the appropriate conductor anywhere in the ship, sufficient conductivity to the steel hull may exist for the over-current device to disconnect the heating tape circuit.

The testing laboratory that performed the CPSC studies on residential heat tapes concluded that a ground fault circuit interrupter (GFCI) provided reliable protection against fire from failed shielded heat tapes. The installation of a GFCI to supply heating tapes with an ungrounded electrical system aboard a steel-hulled ship may or may not provide additional protection against fires. The following scenarios are possible:

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[35]Established under the authority of 46 USC 4508, the 17-member CFIVSAC advises the Coast Guard Commandant, Secretary of Transportation, and Congress on safety issues related to commercial industry fishing vessels. Committee members include crewmembers or processors on uninspected fish processing vessels, naval architects or marine surveyors, manufacturers of industry equipment, industry educators or trainers, insurance underwriters for fishing vessels as well as the general public.

a. If heating tape conductors do not touch ground and the arc does not result in sufficient current flow, a fire may start because the over-current protecting device may not disconnect. Additionally, the heating tape circuit supplied from a GFCI will not disconnect the circuit because a GFCI functions only when the protected circuit sustains a loss of current to ground.

b. If either heating tape conductor touches the hull, the results will resemble the scenario above, except if unintended electrical grounds already exist, the GFCI will cause an opening of the electric circuit at very low leakage currents. The GFCI to that extent may reduce the probability of fire incidence; however, it is not a predictably reliable protection from fires caused by heat tape failures.

A GFCI would, therefore, not be reliable in preventing a heat tape-initiated fire. Because no marine standards or regulations regarding the use of heat tape on vessels exist and fires aboard vessels using heat tape have occurred, the Safety Board concludes that a national marine safety standard for vessels on the safe use of heat tape is needed. Therefore, the Safety Board believes that the Coast Guard and the National Fire Protection Association (NFPA)[36] should establish, in cooperation, a national marine safety standard on the safe use of heat tape, heat tape insulation, and methods to detect heat tape failure on vessels.

The access door on the freezer deck that led from the mezzanine area was open, allowing the fire to spread quickly from hold No.3. Smoke was first reported to be exiting from around this closed insulated door, and the door should not have been opened. However, it was opened during the initial efforts to locate the fire, could not be closed because of flames from hold No.3, and remained open. This open door allowed the flames and combustible gases that ignited the RPU insulation on the freezer deck to escape, provided more ventilation for fire growth, and intensified the fire in the freezer hold. Had this door remained closed, the fire would have continued to spread but at a slower rate and may have been limited to this hold.

The RPU insulation that was used extensively throughout the refrigerated spaces was the primary fuel for the fire, which then spread upward from the freezer deck to the processing deck through the forward and aft elevator shafts. The large watertight door on the freezer deck, allowing access to the aft elevator shaft, was found open after the fire and had provided the initial means for the fire to reach the processing deck. The opening to the forward elevator shaft on the freezer deck had apparently been boarded over with plywood and then sprayed with RPU foam insulation, which were found completely burned away after the fire. This unobstructed opening to the forward elevator furnished access for the fire spread to the decks above. Based on the fire damage pattern, the fire progressed from hold No.3, to the freezer deck, to the processing deck, and finally to the weather deck.

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[36]The nonprofit NFPA advances the development and dispersion of fire safety standards of which many are adopted into Federal, State, and municipal fire codes. The association volunteers are in such professions as fire service, health care, business, insurance, government, education, and industry.

The main route of fire progression appears to have been through the open doors and the elevator shafts. Both elevator shafts were covered inside with the RPU foam insulation. The openings to the elevator shafts, one each in holds No.2 and No.3, were covered with heavy rubber roll-up doors that were not seriously fire damaged. The fire appears not to have spread from hold No.3 upward to the next deck through these shafts; however, the fire damage indicates that the fire did spread upward from the freezer deck through both elevator shafts. The openings on the freezer deck to both shafts provided an effective chimney and route for the fire spread to the above decks. Paint was burned off from the waterline upward near the elevators on the port side of the vessel. The scorch marks on the outside hull at the elevators are consistent with the determination that these shafts provided an effective route for upward fire spread. The Safety Board therefore concludes that the fire spread rapidly because doors were left open allowing the fire to spread from deck to deck as well as horizontally on decks and unprotected RPU foam insulation was used extensively throughout the vessel.

The combustible material that principally contributed to the rapid fire spread was the RPU foam insulation. The addition of fire-retarding chemicals to foam-forming chemicals increases the difficulty of ignition, but once ignition occurs, flame spread is very rapid. Sprayed-on exposed RPU foam insulation was used for thermal insulation during the 1960s and early 1970s in shoreside structures as it was used on the ALL ALASKAN. Because a number of fires had developed very rapidly in the RPU material, the model building codes were modified to prevent the use of uncovered cellular plastics on shoreside installations. The cellular plastics, including RPU foam insulation, must be covered with a noncombustible covering to reduce the likelihood of ignition and fire spread.

Rigid Polyurethane Foam Insulation

Coast Guard NVIC No. 8-80 states:

> [W]hen organic foams (including those described as self-extinguishing, non-burning, fire resistant, flame resistant, and similar terms) are exposed to fire or heat, they may ignite and burn with rapid flame spread, high temperatures, toxic gases and voluminous quantities of smoke.

When RPU foam insulation is properly installed and protected by a noncombustible material, according to NVIC No. 8-80, it is no more of a fire hazard than other combustible materials. The NVIC No. 8-80 also provides guidance on the proper protection of RPU insulation.

The commercial uninspected fishing industry vessel regulations permit combustible insulation in cargo spaces and refrigerated service spaces and have no requirement about the type of foam (fire retarding or not) or other combustible insulation used in these spaces or how it should be installed and protected. The regulations do not require smoke and fire detectors or fixed fire extinguishing systems for these spaces. No requirement stipulates what constitutes a

proper installation for owners, inspectors, or accepted organizations to follow when a combustible material, such as RPU foam insulation, is used.

NVIC No. 5-86 recommends the use of smoke or fire detectors in galleys, accommodations, and other high fire risk spaces as well as the use of a fixed carbon dioxide fire extinguishing system to protect cargo spaces with a high fire risk. However, what constitutes a high fire risk is not defined. The Safety Board has determined that large spaces insulated with RPU foam should be considered a high fire risk and that smoke or fire detectors should be used within these high fire risk spaces. The Coast Guard does require a fixed fire extinguishing system in cargo holds if the holds carry explosives, combustible liquids, or automobiles. However, it does not require this system be installed in the spaces insulated with combustible construction material in which people work at sea. These spaces should also be required to be protected by a fixed fire extinguishing system. The above items should be included in a national marine safety standard when combustible insulation material is used in cargo spaces.

After the Commercial Fishing Industry Vessel Safety Act of 1988 was enacted, the Coast Guard developed regulations for the fishing industry vessels. Despite the applicable details of NVICs No. 8-80 and No. 5-86 and the warnings in the WPI report concerning foam (combustible insulation) and its hazards, requirements were not incorporated into these regulations (46 CFR part 28) when published on August 14, 1991. These regulations should have requirements about combustible insulating materials installation and protection in cargo holds and other service spaces. However, despite the lack of Coast Guard regulations, the NVICs provide guidance that the AAS should have used to improve the fire safety of the ALL ALASKAN. Had the AAS complied with the NVIC recommendations, the RPU foam would have been covered with noncombustible material, and the fire after igniting would likely have been contained in a small area.

The model building codes recognized and effectively dealt with the fire problem associated with cellular plastics almost 20 years ago. Unfortunately, this shoreside approach to fire safety has not been translated into fishing industry vessel fire safety codes and regulations. Should Coast Guard regulations continue to permit RPU foam or other organic combustible material insulations to be used in cargo holds and service spaces, the requirements for these combustible materials should be revised using the land-based fire protection standards to establish similar fire safety standards (construction and structural fire protection and fixed firefighting system) for fishing industry vessels. These requirements should include covering the combustible insulation with a noncombustible material, physically separating heat-taped equipment from combustible insulation with a noncombustible material/insulation, and installing smoke and fire detectors and a fixed fire extinguishing system in spaces equipped with these materials. The Safety Board concludes that a national marine fire safety standard for the safe use of RPU foam and other organic combustible material insulations on vessels is needed. Therefore, the Safety Board believes that the Coast Guard and the NFPA should establish, in cooperation, a national marine fire safety standard on the safe use of RPU foam and other organic combustible material insulations on vessels.

Fire Watch Procedures

The master of the ALL ALASKAN, although not required by regulation, assigned a roving fire watch every 1/2 hour on a 24-hour basis whenever the vessel was underway and not processing because he was concerned about the risk of fire. About 8 1/2 hours elapsed between the fire watch first detecting an unusual smell that indicated possible overheating and the outbreak of the fire. The fire watch smelled the odor during every 1/2-hour tour through hold No.3 and other engineering personnel smelled the odor on some 10 occasions during this period; however, no one conducted a thorough examination to locate the odor.

The electrician was not awakened nor were procedures initiated to isolate the electric circuits to cargo hold equipment, which could have been shut down and then activated sequentially. The watertight doors between holds could have been closed to isolate the holds and the odor. Neither the chief mate nor the master had been informed about the odor during this 8 1/2-hour period.

The chief mate after being relieved at 0530 was having breakfast when he overheard the assistant engineer talking about a smell and understood the phrase "electric motor." The overheard conversation did not concern or alarm him because as he stated the engineers on a processing vessel are "always looking for a peculiar smell of some sort." Since he then retired to his room to sleep, he appeared not to have been disturbed by the report of the odor.

Regulations for passenger vessels not equipped with fire watch recording apparatus in the control station require that the fire watch on duty report to the bridge once each hour. The master of the ALL ALASKAN had instructed his fire watch to notify him if the fire watch discovered smoke or anything that did "not look right." However, he did not have procedures or criteria in place that require a fire watch to report either to the bridge every hour or an unusual or odd odor that could not be located and identified. Furthermore, the AAS had not provided any written guidance to the master for fire watch procedures or actions to be taken when odors are discovered and not identified.

The crew also appears not to have been alarmed by the odor, even though they did expend some effort to identify its source. Their concern never reached the level to motivate them to isolate electrical equipment or to notify the master who should have been notified when he came on duty at 0530 (for the 0600-1800 watch), which was between 4 1/2 and 5 hours after the odor had first been detected. The crew's ineffectiveness in notifying the master of the odor in a timely manner precluded him from taking action to locate and eliminate the source and to have effectively prevented or extinguished the fire. Once smoke was detected and he was notified, it was then too late for him to do anything about it.

The 8-12 fire watch had passed through hold No.3, according to the fire watch's testimony, 15 to 20 minutes before the refrigeration technician detected smoke around the edge of the door to hold No.3. A fire of the magnitude that occurred aboard the ALL ALASKAN on

July 24, 1994, must have had some visible indication to anyone then passing through the compartment, particularly when that person is tasked to specifically look for signs of fire. The Safety Board therefore concludes that the crew's efforts to locate the source of the odor in hold No.3 were inadequate and their investigation to determine the cause of this odor should have been more extensive.

Survival Aspects

Firefighting Training – The circumstances of this accident clearly show the hazards of firefighting and the need for fire team members who are to fight a fire to be thoroughly trained in accepted procedures. Such training in marine firefighting schools ashore is provided by professional and qualified instructors. Formal training is better than routine drills because fire theory is studied, hands-on and varied firefighting situations are enacted under controlled conditions, and proper firefighting procedures are followed.

Deficiencies in the firefighting capabilities of the crewmembers who attempted to enter hold No.3 were apparent. Although the AB and deckhand felt the cargo hold door for heat, they either did not consider or were unaware of the insulating property of the RPU foam on the far side of the door. When the AB and deckhand opened the door leading down to the cargo hold, smoke and flames rushed out at them through the open doorway. This additional air entering hold No.3 when the door was opened created a chimney effect.

The AB and deckhand opened the door to hold No.3 without backup from other fire team members. The AB carried a fire extinguisher, and each wore a firefighter's coat with a SCBA. However, neither had SCBA training during actual smoke conditions. The burn pattern on the deckhand's face after his body was recovered indicated that he was wearing the SCBA face piece when he died. He was not wearing a harness to which a lifeline could be attached.

Title 46 CFR 28.205(e) requires SCBAs to provide a 30-minute minimum of air; however, the breathing rate of a person under exertion can deplete the air supply in less time. The breathing rate of the deckhand probably increased when he saw the flames and exerted himself while trying to escape. The AB stated that he had depleted the SCBA air supply shortly after leaving the freezer deck and he believed the deckhand may have exhausted his air supply either before or when he himself had because both had put on the SCBAs about the same time. The deckhand would have been overcome in seconds by the smoke once the SCBA air supply was exhausted.

The smoke seen coming from the hold No.3 door was quickly reported, but response was not in a manner normally recognized as acceptable for fighting fires aboard ship. The AB and deckhand, after donning the SCBA gear and firefighter coats, failed to receive instructions from the chief mate, who was in charge of the fire team, before attempting their firefighting operations. Their hurried unplanned response to check out the smoke from the closed freezer

deck door not only lacked the methodical approach to investigate and to fight a fire but also proved unsafe and ineffective, resulting in the deckhand's death. The team also never discussed what escape method, such as the use of lifelines, would be used should they become disoriented or whether charged hoses should be available as the door was opened. Had the fire in the hold been discovered in its beginning phase, hand-held equipment may have effectively extinguished it. However, because of the magnitude of the fire from the rapid flame spread through the RPU foam insulation by the time the seeping smoke was discovered, the firefighters could not effectively fight the fire with the hand-held equipment.

Had members of the fire team aboard the ALL ALASKAN received formal firefighting training in addition to shipboard fire drills, they would have been able to assess the fire and to coordinate their actions with a back-up fire team. They would have also known how to use lifelines with SCBAs to avoid being lost in smoke conditions. The AB testified that he had not received training in fire containment during the fire drills that were held as required. Although mock fires were simulated during drills, the AB had never used lifelines during drills, and, thus, his incomplete training did not prepare him for this situation. Therefore, the Safety Board concludes that because the AB and deckhand had no formal firefighting training, they were unable to properly assess the smoke conditions at the hold No.3 door that resulted in a more critical dilemma than before the door was opened.

Formal marine firefighting training provides an understanding of firefighting procedures and techniques as well as the classes of fire, the spread of fire, and extinguishing agents. This accident indicates that in addition to the fire drills aboard the ALL ALASKAN, formal training may have benefited the AB and deckhand. Coast Guard-approved basic and advanced firefighting training is available at various locations throughout the United States. However, the Coast Guard only requires licensed officers to have this training. The vessel crew is responsible for fire containment because a fishing vessel may be a great distance from shoreside firefighting assistance. The experience and training of the firefighting team can make the difference not only between extinguishing a fire and losing a vessel but also between personal safety and loss of life. About eight crewmembers on the ALL ALASKAN would need this formal training. Crew error is likely reduced when crewmembers on the firefighting team, in addition to the licensed officers, receive formal firefighting training. The Safety Board concludes that a Coast Guard requirement for formal marine firefighting training for crewmembers assigned to fire teams on fishing vessels is needed. Therefore, the Safety Board believes that the Coast Guard should amend 46 CFR 28 subpart C to include a requirement that people assigned to firefighting teams be trained in proper firefighting procedures and emergency equipment use and also that those assigned to fire watch duty be trained in proper fire detection procedures.

Lifeline Usage During Fire Drills – The deckhand probably became disoriented after encountering the flames and heavy smoke and was unable to locate the door leading into the refrigeration machinery room. Using a lifeline would have made it possible either for the deckhand to find his way out or for others to locate him had he needed assistance. The AB stated that he was aware of the lifelines in the fire lockers but had never been trained in their use during

fire drills. Therefore, the Safety Board concludes that had the AB and deckhand used lifelines when entering the freezer deck and been trained in their use during fire drills or formal firefighting training, the deckhand may have found his way to safety or signaled for help.

Safety Operations Manual -- The ALL ALASKAN safety manual contains firefighting operation guidelines; however, the AB said that he was not aware of any manual aboard the ALL ALASKAN. He stated that his training had been received only verbally and only during fire drills. The firefighting appendix to the safety manual included prefire planning and fire precautions, but these were not taught during drills. Had the safety manual precautions, such as having a charged fire hose available when entering smoke-filled compartments and using lifelines plus SCBA apparatus when opening areas, been taught to the firefighting team and practiced during drills, the AB and deckhand may have exercised these safeguard precautions in this accident. Safety manual firefighting procedures are only beneficial when taught to crewmembers in practice emergency situations. The Safety Board concludes that had the ALL ALASKAN safety manual procedures been provided to the AB and used during fire drills, the consequences of the fire may have been lessened. Therefore, the Safety Board believes that the AAS should ensure its vessel crewmembers with responsibilities in emergencies are knowledgeable of the company safety manual contents, such as the use of lifelines, fire assessment, and fire team coordination, to enforce proper firefighting procedures.

Company Safety Training Oversight -- The company had the responsibility to ensure that the vessel operated safely and efficiently. The master was responsible for all vessel operational decisions, and the on-board vessel superintendent was responsible for the processing operation. Although the company president had conducted ship visits, these visits focused on the fish processing operation.

Although frequent drills were held at the urging of the master, neither how much training each member of the firefighting team had received nor how well the drills served as a training aid was routinely determined. The vessel had one major fire during its conversion; according to crew testimony, it had experienced several "small" fires before this casualty; and the AAS was probably aware of the major fire on the fish processing vessel OMNISEA in Seattle, all these incidents should have highlighted the AAS concern for potential fire emergencies. The company had no system to detect fires; however, fire detection (outside of accommodation spaces), either by an installed system or crewmember fire rounds, is not required for this vessel. Of his own volition from his stated concern about a foam fire, the master had instituted fire watches when the vessel was underway and not processing. The Safety Board concludes that the AAS because of its experience with the past fires should also have recognized the problem and provided written fire watch guidance to the master. Therefore, the Safety Board believes that the AAS should provide written guidance on fire watch procedures and duties for its vessel masters and also for those employees who are assigned to fire watch duty.

Despite the lack of regulatory requirements for fire protection and firefighting training, the AAS had responsibility for the ALL ALASKAN and the safety of its personnel. Although the

company had taken measures to improve safety on its vessels, formal fire team training and guidance is needed to further improve vessel fire safety. The Safety Board therefore believes that the AAS should provide members of the fire team aboard its fish processing vessels with formal marine firefighting training.

Rescue -- The master of the ALL ALASKAN immediately radioed for assistance when he recognized the fire was out of control. Because the processors and crewmembers were familiar with the abandon ship procedures and survival equipment from participating in frequent drills, which included one on the previous day, they were able to abandon the vessel in an orderly manner. The abandonment occurred during daylight hours and with calm seas. In addition, the PT. MILNE and INDEPENDENCE crews were instrumental in evacuating crewmembers and processors safely from the ALL ALASKAN and transporting them to Dutch Harbor. The Coast Guard arrival on scene about 3 hours later was timely, considering the JARVIS was on area patrol and traveled a 70-mile distance. The nearest Coast Guard base to the rescue site is over 300 miles away. The Safety Board therefore concludes that the frequent abandon ship drills conducted aboard the ALL ALASKAN resulted in an orderly and successful abandonment of the vessel and that rescue efforts were timely and appropriate.

The ALL ALASKAN was drifting toward Unimak Island after the JARVIS arrived on scene and would have likely become a potential environmental problem had the vessel grounded and its fuel tanks breached. The master and two JARVIS crewmembers boarded the ALL ALASKAN and prepared it for towing, enabling the fishing vessel SHELIKOF to take the ALL ALASKAN in tow before it could ground. A potential major environmental hazard was probably avoided because of these actions.

Toxicology Issues

Crew -- The urine specimen obtained from one off-duty processor on board the ALL ALASKAN tested positive for a metabolite of marijuana. The remaining 21 specimens tested negative for the presence of drugs.[37] Title 46 CFR 4.06-10 stipulates that individuals required to undergo chemical testing submit urine and blood or breath specimens "as soon as practicable" and that the responsibility for determining who will be tested as well as for the testing itself rests with the marine employer. Considering the circumstances of this accident, the postaccident crew drug testing, with the exception of the master, was accomplished as soon as could be reasonably expected.

Master -- Coast Guard personnel on board the JARVIS did not conduct postaccident alcohol testing of the master, even though breathalyzers were on board for alcohol testing. According to the Coast Guard, the breathalyzers are normally used to test either Coast Guard

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[37]The five drugs and/or their metabolites, specified in 49 CFR part 40 for testing, are cocaine, amphetamines, marijuana, phencyclidine, and opiates.

personnel or mariners who are suspected of having consumed alcohol. No overt indications were present that the master was impaired at the time of the accident. The JARVIS was not supplied with equipment for civilian use that would permit the collection of urine or blood specimens for toxicological testing; nor is it required. The master testified that during his stay aboard the JARVIS, Coast Guard personnel on one occasion discussed the need for him to undergo postaccident testing, although no tests were administered. The commanding officer of the JARVIS stated that the subject of postaccident testing was never discussed during the time the master was on board. The Safety Board is concerned that the master never underwent postaccident testing and is unable to determine whether the master was free of illegal drugs and alcohol at the time of the accident. The Safety Board therefore concludes that no evidence indicated that alcohol or drug use caused or contributed to the accident.

As the entity ultimately responsible for postaccident chemical testing, the AAS failed to ensure that the master had postaccident testing. The company should have vigorously pursued allegations that the master underwent testing "somewhere on the East Coast" and insisted on documentation to that effect. Although AAS personnel were likely required to attend to other postaccident business, such as crew and vessel matters, these responsibilities did not preclude their obligation to ensure that the master underwent timely postaccident chemical testing. Had the AAS identified chemical testing as a critical element of the postaccident events, the master would have provided specimens as soon as practicable. (See appendix D for a review of recent regulatory and industry oversight of the chemical testing program.)

The master taking prescription medication did not appear to be a factor in this accident, but the Safety Board is concerned about the possible effects of medication on performance. As a result of its investigation into the collision of the towboat MAUVILLA with a railroad bridge,[38] the Safety Board recommended on September 30, 1994, that the employer of the operator of that vessel:

M-94-45

> Establish procedures that encourage towboat operators to inform management when they are taking medication, to determine whether such medication may affect performance of their duties, and to arrange for a qualified relief, if necessary.

This recommendation has been classified "Closed--Acceptable Action" because the towing company complied with the intent of the recommendation. According to the company, it:

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[38] Railroad-Marine Accident Report--*Derailment of Amtrak Train No.2 on the CSXT Big Bayou Canot Bridge near Mobile, Alabama, on September 22, 1993* (NTSB/RAR-94/01).

established a medical monitoring program to ensure fitness for duty of those operators who are on medication or who are returning to work following an illness or extended absence (60 days or more). In addition, the company encourages these personnel, at no cost to the employee, to participate in periodic, voluntary physical exams.

Such a medical monitoring program to ensure fitness for duty would enable the AAS to be aware of employees' medications, to determine whether such medications may affect performance, and to arrange for a qualified relief, if needed. Therefore, the Safety Board believes that the AAS should develop and institute procedures designed to require employees to inform management of any medication being taken that could potentially affect performance.

CONCLUSIONS

1. The weather conditions and the vessel mechanical systems were not factors in the accident.

2. The ignition source for the fire was the failure of the heat tape on the 2-inch diameter vertical drain pipe in hold No.3 on the port side aft, which was the lowest point of the fire.

3. The crew's efforts to locate the source of the odor in hold No.3 were inadequate and their investigation to determine the cause of this odor should have been more extensive.

4. The fire spread rapidly because doors were left open allowing the fire to spread from deck to deck as well as horizontally on decks and unprotected rigid polyurethane foam insulation was used extensively throughout the vessel.

5. Had the rigid polyurethane foam insulation in hold No.3 been physically separated from the heat tape failure by a noncombustible material, the fire may not have occurred.

6. A national marine fire safety standard for the safe use of rigid polyurethane foam and other organic combustible material insulations on vessels is needed.

7. A national marine safety standard for vessels on the safe use of heat tape is needed.

8. Because the able seaman and deckhand had no formal firefighting training, they were unable to properly assess the smoke conditions at the hold No.3 door that resulted in a more critical dilemma than before the door was opened.

9. Had the able seaman and deckhand used lifelines when entering the freezer deck and been trained in their use during fire drills or formal firefighting training, the deckhand may have found his way to safety or signaled for help.

10. A U.S. Coast Guard requirement for formal marine firefighting training for crewmembers assigned to fire teams on fishing vessels is needed.

11. Had the ALL ALASKAN safety manual procedures been provided to the able seaman and used during fire drills, the consequences of the fire may have been lessened.

12. Considering the master had recognized a potential fire problem and instituted fire watches, All Alaskan Seafoods, Inc., because of its experience with the past fires should also have recognized the problem and provided written fire watch guidance to the master.

13. The frequent abandon ship drills conducted aboard the ALL ALASKAN resulted in an orderly and successful abandonment of the vessel, and the rescue efforts were timely and appropriate.

14. No evidence indicated that alcohol or drug use caused or contributed to the accident.

PROBABLE CAUSE

The National Transportation Safety Board determined that the probable cause of the fire aboard the ALL ALASKAN was the failure to isolate heat tape from combustible rigid polyurethane insulation and the lack of heat tape standards for fish processing vessels. Contributing to the severity of the fire was the lack of adequate firefighting (detection and suppression systems) standards. Contributing to the loss of life was the lack of formal firefighting training of the fire team.

RECOMMENDATIONS

As a result of its investigation of the ALL ALASKAN accident, the National Transportation Safety Board makes the following recommendations:

--to the U.S. Coast Guard:

Amend 46 Code of Federal Regulations 28 subpart C to include a requirement that people assigned to firefighting teams be trained in proper firefighting procedures and emergency equipment use and also that those assigned to fire watch duty be trained in proper fire detection procedures. (Class II, Priority Action)(M-95-13)

Amend 46 Code of Federal Regulations 28 subpart D to require that equipment using heat tape be physically separated from rigid polyurethane foam and other organic combustible material insulations by a noncombustible material. (Class II, Priority Action)(M-95-14)

Establish, in cooperation with the National Fire Protection Association, a national marine safety standard on the safe use of heat tape, heat tape insulation, and methods to detect heat tape failure on vessels. (Class II, Priority Action)(M-95-15)

Establish, in cooperation with the National Fire Protection Association, a national marine fire safety standard on the safe use of rigid polyurethane foam and other organic combustible material insulations on vessels. (Class II, Priority Action)(M-95-16)

Publicize the circumstances of this accident to the fishing industry. (Class II, Priority Action)(M-95-17)

--to All Alaskan Seafoods, Inc.:

Provide written guidance on fire watch procedures and duties for its vessel masters and also for those employees who are assigned to fire watch duty. (Class II, Priority Action)(M-95-18)

Provide members of the fire team aboard its fish processing vessels with formal marine firefighting training. (Class II, Priority Action)(M-95-19)

Ensure its vessel crewmembers with responsibilities in emergencies are knowledgeable of the company safety manual contents, such as the use of lifelines, fire assessment, and fire team coordination, to enforce proper firefighting procedures. (Class II, Priority Action)(M-95-20)

Inspect its fish processing vessels that use heat tape to ensure the heat tapes are physically separated from rigid polyurethane foam and other organic combustible material insulations by a noncombustible material. (Class II, Priority Action)(M-95-21)

Develop and institute procedures designed to require employees to inform management of any medication being taken that could potentially affect performance. (Class II, Priority Action)(M-95-22)

--to the Commercial Fishing Industry Vessel Safety Advisory Committee:

Advise fishing vessel owners to inspect their vessels that use heat tape to ensure the heat tapes are physically separated from rigid polyurethane foam and other combustible material insulations by a noncombustible material. (Class II, Priority Action)(M-95-23)

--the National Fire Protection Association:

Establish, in cooperation with the U.S. Coast Guard, a national marine safety standard on the safe use of heat tape, heat tape insulation, and methods to detect heat tape failure on vessels. (Class II, Priority Action)(M-95-24)

Establish, in cooperation with the U.S. Coast Guard, a national marine fire safety standard on the safe use of rigid polyurethane foam and other organic combustible material insulations on vessels. (Class II, Priority Action)(M-95-25)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JAMES E. HALL
Chairman

ROBERT T. FRANCIS II
Vice Chairman

JOHN A. HAMMERSCHMIDT
Member

July 11, 1995

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING/DEPOSITION

Investigation

The Coast Guard notified the Safety Board of this accident on July 25, 1994. Six investigators from the Safety Board headquarters in Washington, D.C., were immediately dispatched to Dutch Harbor, Unalaska Island, Alaska, to commence the accident investigation. Another investigator left for the scene on July 28, 1994.

The Safety Board and the Coast Guard investigated the accident jointly under the authority of Section 304(a)(1)(E) of the Independent Safety Board Act of 1974 and in accordance with 49 CFR 850 (Coast Guard-NTSB Marine Casualty Investigations).

The Safety Board has considered all facts in the investigative record that are pertinent to its statutory responsibility to determine the cause or probable cause of the accident and to make recommendations. The Safety Board has made its analyses and recommendations independently of the Coast Guard.

The All Alaskan Seafoods, Inc., the master and chief engineer of the ALL ALASKAN, the estate of the deceased deckhand, and Raychem Corporation were parties in the investigation.

Hearing/Deposition

A joint Coast Guard/Safety Board investigation board took sworn testimony from July 29 through August 5, 1994, at the Federal courthouse in Anchorage, Alaska. The Safety Board did not conduct a separate public hearing during the investigation.

Two investigators examined the vessel damage on October 4 and 5, 1994, in Seattle, Washington. On February 15, 1995, an investigator obtained heat tape for testing from the vessel in Seattle. Two investigators went to Chicago, Illinois, on February 23, 1995, to witness with two interested parties the heat tape testing at Underwriters Laboratories. As a result of information received during testing in Chicago, two investigators visited the vessel on March 14, 1995, to examine the aft port corner of cargo hold No.3.

APPENDIX B

CREW INFORMATION

Master

Thomas P. Marshall, age 39, began working for the AAS as a deckhand on December 19, 1986. He continued working for the AAS as a mate aboard one of its fish processing vessels after he obtained his mate's license. When he received his master's license in 1991, he became the master aboard the ALL ALASKAN.

Chief Mate

Thomas A. Gates, age 46, stated that he began working in commercial fishing in 1971. He received his first merchant mariner's document (master, uninspected 300 tons) in 1982. He worked between 1982 and 1985 as master or mate on oil field supply vessels. Returning to the fishing industry in late 1985, he subsequently worked as boatswain, deckhand, and mate. The AAS records disclosed that his employment began May 26, 1994. He reported that since June 5, 1994, he had been aboard the ALL ALASKAN.

Assistant Engineer

Melvin J. Kufeldt, age 36, stated that he began working commercial fishing vessels in 1984. He had worked as an ALL ALASKAN crewmember since May 1989. In April 1994, he was issued a license as chief engineer (limited-near coastal) of motor vessels of not more than 5,000 horsepower and of uninspected fishing industry vessels of not more than 5,000 horsepower, was designated duty engineer of motor vessels of any horsepower, and also licensed as assistant engineer (limited oceans) of motor vessels of not more than 5,000 horsepower.

Able Seaman

Brent A. Reid, age 33, had been on the ALL ALASKAN for 4 years and held seaman papers, issued by the Coast Guard in October 1992, for an able seaman-fishing industry.

Deckhand

Kyle Smith, age 22, had been hired by the AAS as a fish processor on June 11, 1993. He had no previous seagoing experience.

APPENDIX C

UNDERWRITERS LABORATORIES, INC. TEST REPORT

Test Report

Special Services Investigation
Testing of Electrical Heat Tape

NTSB12-95-SP-0311

March 8, 1995

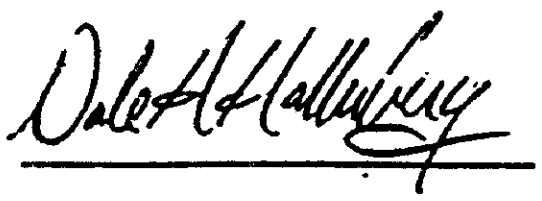
Performed For :

National Transportation Safety Board
490 L'Enfant Plaza East, S.W.
Washington, D.C. 20594

Performed By:

Underwriters Laboratories Inc.
333 Pfingsten Rd.
Northbrook, IL 60062

UL Reference: Project # 95NK3622



Dale A. Hallerberg, P.E.
Staff Engineer
Underwriters Laboratories Inc.
(708) 272-8800 (x-43224)

APPENDIX C

1. Introduction

This report summarizes the results of testing conducted for the U. S. National Transportation Safety Board under Order No. NTSB12-95-SP-0311.

2. Use of Report

In no event shall UL be responsible to anyone for whatever use or nonuse is made of the information contained in this Report and in no event shall UL, its employees or its agents, incur any obligation or liability for damages, including, but not limited to, consequential damages arising out of or in connection with the use, or inability to use, the information contained in this Report.

Information conveyed by this Report applies to the specimens actually involved in the test. UL has not established a factory follow-up service program to determine the conformance of subsequently produced material, nor has any provision been established to apply any registered mark of UL to such material.

The issuance of this Report in no way implies Listing, Classification, or Recognition by UL and does not authorize the use of Listing, Classification or Recognition Marks or any other reference to UL on or in connection with the product or system.

3. Instrumentation

The following meters were used during the testing:

Measuring	Meter No.	Last Calibration Date	Calibration Due Date
Time	TO 8005	10-13-94	10-12-95
Mass	SC 3011	1-11-95	1-10-96
Voltage	DMM 8014	2-15-95	2-14-96

4. Samples

Two distinct heating cable samples were tested:

1. Samples of used heating cables reported to be from the vessel under examination, provided through the NTSB.

2. Samples from a 100 ft. reel of new heating cable, provided by Raychem Corp.

Following testing, the used samples were returned to their origin. The new heating cable, both tested and untested, was returned to the NTSB.

5. Method

Unless otherwise noted in the Test Results, the end of each sample was cut perpendicular to the axis of the heating cable. The end of each sample was held in place so that drips of saltwater would collect on the end of the cable. Several concentrations of saltwater were used, from 35 g/l (roughly representing seawater) to 200 g/l (Saltwater tolerances are ±10%). Each sample was wired to a 121Vac supply and energized.

A pipette was arranged above the cable to drip the saltwater solution onto the cable end. The drip rate was adjusted as testing progressed in order to try to allow each drop of saltwater to boil off before the next drip was applied.

6. Test Results

Results apply only to the samples tested.

6.1 Test Sample: New heating cable
Cable length: Approximately 9m
Saltwater: 200 g/l
Result: The saltwater induced a sputtering arc between the two bus wires across the self-regulating core of the heating cable. In time, the arcing self-sustained without further saltwater application. Not long after the arcing self-sustained, the cable began burning. The test was stopped soon after burning initiated.
Time: Fire at 4:04 (4 minutes, 4 seconds), stopped at 4:14.

6.2 Test Sample: New heating cable, same sample as test 6.1 above, but distal end shortened by 5cm.
Cable length: Approximately 9m
Saltwater: 200 g/l
Result: Same as 6.1 above
Time: Fire at 8:50, stopped at 8:54.

6.3 Test Sample: New heating cable, same sample as test 6.2 above, but distal end shortened.
Cable length: Approximately 8-½m
Saltwater: 100 g/l
Result: Same result as 6.1 above.
Time: The sample was inverted and the test restarted at 11:35 because the end of the cable was not getting wet from the saltwater.
Reset clock to zero, inverted back to normal position at 10:55, fire at 13:45, stopped at 13:57.

6.4 Test Sample: Used heating cable, designated Item 2 C-D length.
Cable length: 17 feet 6-¼ in.
Saltwater: 200 g/l
Result: Same as 6.1 above.
Time: Fire at 6:27, stopped at 6:54.

6.5 Test Sample: Used heating cable, designated Item 2 C-D length.
Cable length: 17 feet 4-¼ in.
Saltwater: 35 g/l
Result: Test discontinued. No self-sustaining arcing nor ignition.
Time: Stopped at 27:01.

APPENDIX C

6.6 Test Sample: Used heating cable, designated Item 2 C-D length. The fault location for this test was changed to ¼ in. back from the end of the cable, where a V-shaped notch was cut across the flat side of the cable so that both bus wires and the self-regulating core were exposed.

Cable length: 17 feet 3-¼ in.

Saltwater: 35 g/l for 10 minutes.
then 100 g/l for 8 minutes 45 seconds,
then 200 g/l.

Result: Same as 6.1 above.

Time: Changed to 100 g/l saltwater at 10:00,
changed to 200 g/l at 18:45,
fire at 20:17, stopped at 20:22.

7. Videotape

The videotape of the testing is enclosed with this report.

APPENDIX D

REGULATORY AND INDUSTRY OVERSIGHT OF THE CHEMICAL TESTING PROGRAM

The Safety Board has addressed the need for improved postaccident alcohol and drug testing procedures in past marine accident reports. It found that the delays in obtaining toxicological samples were excessive and prevented conclusively determining whether alcohol was a factor in accidents,[1] including those in which tests for alcohol were not conducted.[2] The Safety Board recognizes that pursuant to 46 CFR 4.06-1 the marine employer has primary responsibility for conducting postaccident chemical testing. Nevertheless, this accident emphasizes the need for the Coast Guard to develop improved procedures that ensure postaccident toxicological tests take place in a timely manner. The Safety Board had recommended after the grounding of the QUEEN ELIZABETH 2 that the Coast Guard:

> M-93-24
>
> Provide guidelines to boarding officers investigating marine accidents about informing marine employers of their responsibility to conduct toxicological testing and on providing assistance when necessary (such as providing sampling kits and making arrangements for testing with local approved laboratories).

The Coast Guard Commandant responded on September 27, 1993, that he would revise existing marine safety guidelines as recommended.

After its investigation of the towboat CHRIS and tow collision with the Judge William Seeber Bridge, the Safety Board maintained that the Coast Guard should emphasize the time-sensitive nature of sample collection and encourage marine employers to fulfill their responsibilities as soon as practicable following a serious marine incident. The Safety Board then classified M-93-24 "Closed-Acceptable Action/Superseded" by:

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[1]Highway-Marine Accident Report--*U.S. Towboat CHRIS Collision with the Judge William Seeber Bridge, New Orleans, Louisiana, May 28, 1993* (NTSB/HAR-94/03) and Railroad-Marine Accident Report--*Derailment of Amtrak Train No. 2 on the CXST Big Bayou Canot Bridge near Mobile, Alabama, September 22, 1993* (NTSB/RAR-94/01).

[2]Marine Accident Reports--*Grounding of the United Kingdom Passenger Vessel RMS Queen Elizabeth 2 near Cuttyhunk Island, Vineyard Sound, Massachusetts, August 7, 1992* (NTSB/MAR-93/01) and *Collision of the U.S. Towboat FREMONT and Tow with the St. Vincent and the Grenadines-Registered Containership JURAJ DALMATINAC, Houston Ship Channel, December 21, 1992* (NTSB/MAR-93/02).

APPENDIX D

M-94-11

Provide guidelines to boarding investigating marine accidents about informing marine employers of their responsibility to conduct toxicological testing as soon as practicable following the occurrence of a serious marine incident and about providing assistance when necessary (such as furnishing sample collection kits or making arrangements for laboratory tests).

On November 15, 1994, the Coast Guard issued a district instruction directing each Officer-in-Charge of Marine Inspection that after notice of a serious marine incident, to immediately alert the involved marine employer(s) of the responsibility for chemical testing. The Coast Guard also informed districts that casualty investigations are considered incomplete until all chemical test results are received. Coast Guard personnel could suggest local sources for collection materials and services but were not to provide urine collection materials or perform as collection site people. However, the instruction did authorize that qualified Coast Guard personnel could obtain breath specimens when alcohol testing could be done faster than if arranged by the marine employer or when the breath specimens might otherwise not be secured. The Safety Board considers that the guidelines in the Coast Guard district directive will enhance postaccident chemical testing procedures in the marine industry and, therefore, has classified M-94-11 "Closed-Acceptable Action."

On March 31, 1994, the U.S. Department of Transportation Office of Inspector General (OIG) reported on the Coast Guard role with the marine industry drug testing program. This report[3] concluded that the Coast Guard "implementation and oversight of the marine drug testing program was not adequate to ensure marine employers complied with drug testing rules and regulations." The report listed 11 recommendations, which were designed to strengthen Coast Guard regulations, to provide guidance to marine employers, and to improve Coast Guard oversight of the industry drug testing program. The Coast Guard concurred with nine recommendations and has taken or planned corrective actions in the program. (Implementation target dates range from January 1994 to October 1997.) One of these recommendations requires that the Commandant provide comprehensive written guidance to the marine industry for implementing drug testing programs in compliance with Federal regulations and establish a system to ensure employers who are required to drug test receive guidance. The Coast Guard has responded by preparing a comprehensive overview, effective March 25, 1995, to help industry understand the regulations. The Coast Guard did not concur with the OIG recommendations that the Commandant establish the industry drug testing program as a separate component of the Coast Guard Management Control Plan and include in the annual Federal Manager's Financial Integrity Act report to the Secretary that the Coast Guard implementation and oversight was not adequate to ensure marine industry compliance.

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[3] *Report on the Audit of the USCG Industry Drug Testing Program*, Report No. AS-CG-4-008.

END

FILMED

DATE:
10-13-95

NTIS